

DISCOVERY

Monthly Notebook

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British Television

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JULY

1949

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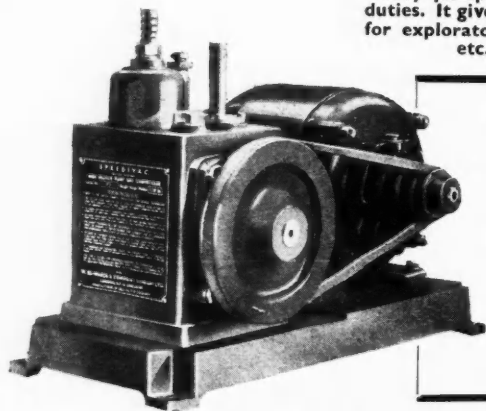
A television producer at the
control panel during a pro-
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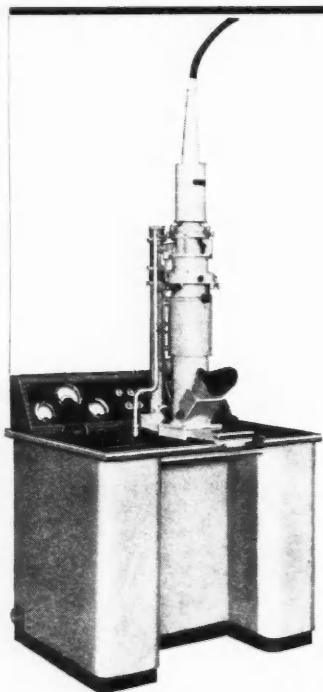
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THE MAGAZINE OF SCIENTIFIC PROGRESS

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Editor WILLIAM E. DICK, B.Sc., F.L.S.

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The Progress of Science

The Briton's Physique

FOR many years it has been noted that young men in different social classes differed greatly in physical development. It has been accepted that the public school boy is heavier and taller than his council school counterpart. When there was a call-up for the Boer War the Army authorities were astounded to find how few of the men were fit for military service. Having originally placed the minimum height at 5 ft. 5 in., it was not long before the authorities were forced to reduce this to 5 ft. Even in the call-up for the 1918 war a disquietingly high percentage of males were found of a low category. In fact to take one local example, of 7728 men examined by the Leicester Medical Board in June 1918, only 19.0% could be placed in Category I. This did not give a true picture of the average physique of the whole male population since many of the fit men had already been called up, but nevertheless it did represent a serious state of affairs.

For some time the physical difference between social classes was attributed to hereditary difference, but during this century it has become appreciated that this difference in physique is fundamentally due to difference in nurture rather than difference in nature. While there is no doubt that the degree of physical development is decided in the first place by intrinsic hereditary factors it is equally true that the hereditary factors cannot exert their full effect without adequate nurture. Of all the constituents of nurture there is no doubt that the most important single one is food. It might be noted that the Medical Boards in 1918 attributed the poor physique in poverty areas, not so much to lack of food, as to their mothers' ignorance of the care and nurture of children and of domestic economy, including cooking. There is no doubt that to some extent this was correct, but we now know that a great proportion of this mal-developed physique was due to lack of foods of the right quality.

Dr. W. J. Martin has now published the results of a survey of the physique of the young men of Britain which he based on an analysis of statistics collected by the Medical Boards of England, Scotland and Wales which examined recruits for the Services during the recent war.

The statistics he analysed gave the details of the examinations of 91,513 men.

In general the conclusions to be drawn from Dr. Martin's report are encouraging; no less than 81.4% of the young men examined were placed in the highest medical category.

There has been an age-old belief that the young man who lives in the country is superior in health and physique to the young town-man and Dr. Martin's survey has now given us sound statistical evidence for this fact. It is also of great interest that this rival superiority extends even to eyesight. Another point worth noting is that the young man from the small town is bigger and better than the young city man. Men who were measured in a part of the country different from that in which they were born, curiously enough, were superior in physique to those who had stayed at home. It may be that only the more physically fit tend to migrate away from home.

In Scotland it was found that Scotsmen do not appear to differ appreciably in stature from their fathers and grandfathers and that the population which lived in highly industrialised cities, such as Glasgow, Motherwell and Paisley, were similar to those of industrialised cities in England and Wales and that they were smaller than the rural Scots.

Welshmen were found to be slightly taller than the preceding generations, but they were 1.7 lb. lighter and 0.4 in. shorter than the national average. This may be partly nature and not entirely nurture because migrants into Wales exceeded the average height of native Welshmen by 0.5 in., though their weight was only 0.8 lb. greater.

REFERENCE

The Physique of Young Adult Males, by W. J. Martin. Issued by The Medical Research Council (H.M. Stationery Office, 1s. 3d.).

Science and the Violin

It is generally believed that violins made today seldom if ever equal the quality of those made by Stradivarius and others of the Cremona tradition before the middle of the eighteenth century. The reasons for this are far from clear. One trouble is that violin makers always have been and

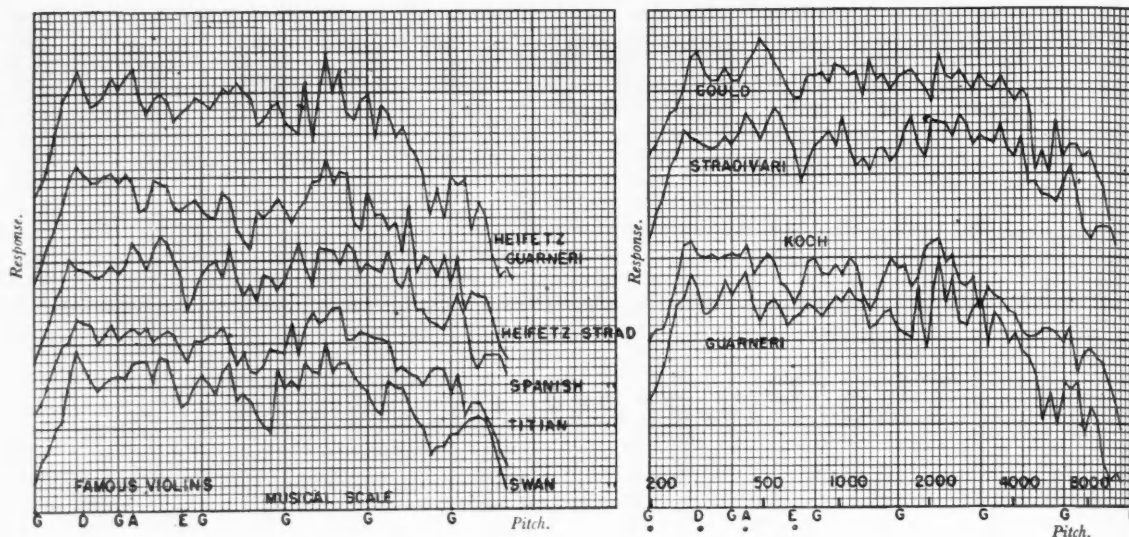


FIG. 1-2.—These curves show intensities of sounds produced by violins when various notes are sounded by mechanical bowing. FIG. 1 (left).—Five famous instruments. FIG. 2 (right).—Old violins and modern copies compared; the lower of each pair of curves refers to an old violin, and the upper to a copy. (After diagrams in the *Journal of the Franklin Institute*, reproduced in *The Physics of Music*, by Alexander Wood, Methuen, 1944.)

still are secretive about their methods and about the reasons that lie behind them. A modern scientist who wants to discover what makes a good violin must start from scratch without benefit of some centuries of craft experience, must check hundreds of infinitesimal details, and must himself become a skilled craftsman. Another difficulty arises from the virtual impossibility of deciding whether the superiority of old violins may not be largely due to the mere fact that they are old. Whisky made this year is definitely inferior to that made fifteen years ago; but fifteen years hence it will be as good. May not violins also require a maturing period of the order of two hundred years? When a violin is constantly played for centuries, the stresses arising from its vibrations will tend to cause small cracks in the wood. The cracks will tend to develop in those places where the material puts up the stiffest resistance (in the literal as well as the metaphorical sense) to the modes of vibration which are most used; and so the act of continually playing a violin would gradually enhance its ability to respond to the modes of vibration most wanted. In this and many other ways one can see how mere age could improve the playing quality. The question of whether it actually does so or not may be undecidable till the men of the twenty-second century compare violins surviving from today with recordings which we leave them; but there is some evidence of improvement with age. Just to add one more complication, it is by no means certain that the Stradivarius is really superior to a good modern instrument. In at least one case when an audience was asked to pick a Strad from three violins played in quick succession, the number of correct guesses was just about what would be expected by chance.

However, even if the relative merits of the old and the

new are debatable, it is still possible for the connoisseur to distinguish a good violin from a bad one, and the scientist still has the problem of determining what are the structural features that make the difference. That is no easy problem, for the violin is a very complicated system, in which the quality results from the joint action of the strings, bridge, belly, back and ribs, sound post and bass-bar, and the volume of enclosed air, besides a multitude of minor elements.

Until recently the main approach to the problem (apart from direct attempts to copy old models) has been an analytical one—by analysing and comparing the acoustic properties of violins already in existence. The American worker, F. A. Saunders, arranged for a number of violins to be bowed mechanically and recorded the intensity level of sound produced at each pitch. Some of his results are reproduced in Figs. 1 and 2. The former gives the responses of five famous violins, and the latter gives in pairs the curves for two old violins and two modern copies of them. Each peak on these curves corresponds to a resonance arising from a natural frequency of some part of the violin or its air space. It is easily shown that the first peak corresponds to the resonance of the contained air, and most of the others to the resonance of some mode of vibration of the belly or back. One point that emerges from these studies is that not only the loudness but also the quality changes from note to note. Taking, for example, the top curve of Fig. 1, there is a peak at the second A and a depression near the third. Thus if the second A is played, its second partial (the third A) will be weak. On the other hand there is a depression at the second B and a peak near the third, so that if B is played its second partial will be strong. Thus these two notes will have quite different qualities.

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Although many other far from b good violin other than Recently N to the prob (May 1949, violin. But measured at and measure arrangement characteristi made of pin damping as measuring t wood. Som Fig. 3, that chosen for choice of the for the back. be in tune v D (287-304

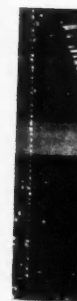
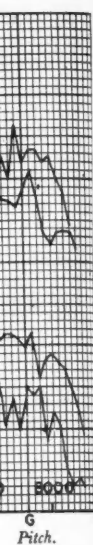


Fig. 3.—each curve for the vi



These figures make it clear that it is very difficult to determine from such response curves just what are the characteristics of a first-class violin. The modern copies of Fig. 2 differ from their models much less than the instruments of Fig. 1 do among themselves. Of course, these curves all refer to good instruments. When good and bad instruments are compared certain obvious differences emerge. It is found, for instance, that in good violins the natural resonances of the body tend to reinforce frequencies between 3200 and 5200 in a fairly even manner, whereas in poor instruments these resonances are about 1000 cycles lower and much less evenly distributed. It is also possible to investigate the effects of varying some of the principle structural elements. Thinner wood decreases the peaks of the response curves and lowers their frequencies. Many almost mystical properties have been ascribed to the varnishes used by the old masters; but investigations of the response curves show that the effect of varnish is small—it moves the peaks to slightly higher frequencies, but the change is so small that it is doubtful whether it could noticeably affect the quality as heard by the ear.

Although research on these lines has revealed a good many other facts of a similar nature, it still leaves us very far from being able to state the acoustical qualities of a good violin, much less to say how to construct a violin—other than by trial and error—that will have these qualities. Recently N. Nicholas has tried a new, synthetic, approach to the problem and has described his results in *Research* (May 1949, pages 237–42). He set out to construct a good violin. But instead of merely copying an old master, he measured at every step the characteristics to be reproduced, and measured the various potential materials and structural arrangements until he found one that gave the required characteristics. The belly of an old master was always made of pine, and it is known that it should have as little damping as possible. Nicholas evolved an apparatus for measuring the damping of vibrations in sample strips of wood. Some of the decay curves obtained are shown in Fig. 3, that on the left being from the pine eventually chosen for the belly. Another investigation led to the choice of the maple whose decay curve is shown in Fig. 3d for the back. For a good violin the belly and the back must be in tune with one another. The best tones seem to be D (287–304 cycles/second) and F (342–362 cycles/second);

the absolute pitch need not be very accurate, but the interval should be. The size and shape of belly and back are fixed, so that the tuning can only be done by varying the thickness of the back. The back might be made too thick and then gradually thinned till in tune, but the notes emitted (for example, on striking with a soft hammer) are difficult to assess accurately, so that this method easily leads to irremediable over-thinning of the back. Nicholas adopted the following method. He removed the piece of wood of a xylophone giving D and replaced it by a rectangular piece of the wood from which the belly was made, tuned to the same D. Then for the xylophone note F he substituted a piece of the maple which was to be used for the back, cut to the same length and breadth as the former. This last was gradually thinned until it gave the desired F. By this means sharp and positive tuning could be obtained. The ratio of the thicknesses of the two pieces was found to be 1.46, and it was now only necessary to make the back so that its thickness bore this ratio to that of the belly.

These are only two of the many carefully considered and quantitatively controlled steps by which Nicholas built his violin. He says that the resulting instrument “has a good sonorous tone but is rather exacting to play”.

Mr. Nicholas admits that the secret of a good violin still remains a secret, but adds hopefully: “There is an indication, however, that the fundamental principle will soon be defined. With present equipment and measuring instruments this may be expected as a matter of fact. All that is required is more co-operation among scientists who enjoy a concert played on first-class violins, but who have not yet interested themselves in the problems confronting their makers.”

Sir William Osler (1849–1919)

THAT William Osler, who was born on July 12, 1849, was one of the really great men of his time and perhaps of all time is a proposition that could hardly be challenged. Yet his greatness is hard to define. His laboratory research was small in quantity, good in quality, but never epoch-making. Under his hand the newly founded Johns Hopkins Hospital in Baltimore in 1889 became the earliest organised medical unit in any English-speaking country, revolutionised American practice and greatly influenced English methods. We get nearer to his greatness when we look at his clinical

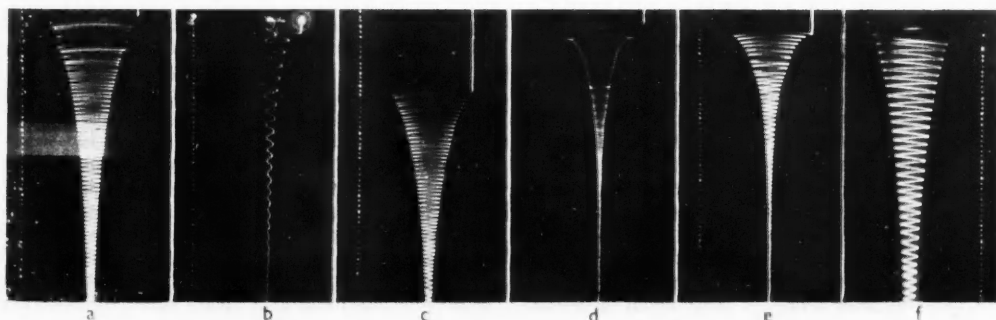


FIG. 3.—Decay curves of test pieces of wood. The curves show how quickly the vibrations die away for each sample. Alongside each curve is a time scale; the interval between the dots on this scale is a tenth of a second. *a* pine cut along the grain (as chosen for the violin's belly), *b* the same cut across the grain, *c* the same cut along the grain and varnished, *d* maple chosen for violin back, *e* cherry wood, *f* balsa wood. (From *Research*, May 1949.)

work and the clinical studies which he published covering a very large part of the field of medicine; and nearer still when we consider him as a clinical teacher. The importance of teaching medicine at the bedside was perhaps his most insistent theme: "To study the phenomena of disease without books is to sail an uncharted sea, while to study books without patients is not to go to sea at all." For his own epitaph he suggested, "I taught medicine at the bedside."

How well he put his principles into practice can only be appreciated by studying his life in detail; yet this insistence on an idea which was growing up in many places would not be enough to qualify him as great. Again he was a leader in the movement to reduce drastically the use of drugs. He was even accused of 'therapeutic nihilism'. Drugs, he taught, should be used only in so far as their effects were well tested and well established. Far more important was nursing to encourage natural recovery. "Time in divided doses" was one of his favourite prescriptions. But this again would not serve to distinguish him as more than a leader in one of the basic general movements of his time. The same may be said of his interest and studies in the history of medicine—though he is perhaps differentiated from others by his fuller realisation that the study of the history of medicine was no mere antiquarian amusement but an essential element in the make-up of a good physician. In fact, almost every specific contribution which Osler made to medicine was of the type which would qualify him for the title of 'a leader of his profession', but not for the epithet 'great'.

Yet all who knew him were convinced that he was great. The truth is that his greatness lay in his power of inspiring others. Accounts by those who worked with him reveal a wonderful personality. One of his assistants described the beginning of a day at Johns Hopkins: "At a few minutes before nine he entered the hospital door. After a morning greeting to the Superintendent, humming gaily, with arm passed through that of his assistant, he started with brisk, swinging step down the corridor towards the wards. The other arm, if not waving gay or humorous greetings to nurses or students as they passed, was thrown around the neck or passed through the arm of another colleague or assistant. One by one they gathered about him, and by the time the ward was reached, the little group had generally grown like a small avalanche." "Wherever he went," wrote another colleague, "the wheels began to go 'round', things began to be done, and all for the good of the profession and the community. The dry bones as in Ezekiel's Vision gathered themselves together and became imbued with active life. The diligent were encouraged to become more diligent, the slothful were shamed into activity. He was a fount of inspiration." From wherever he might happen to be there issued a stream of letters, and especially economically worded postcards, of sympathy, congratulation or encouragement, and (as Cushing tells us) "however delighted his pupils might be to get a postcard from 'The Chief', it was not an unalloyed pleasure, for the card usually contained a memorandum likely to keep the recipient busy for some time." A book might be written on researches inspired by Osler's postcards.

Medical men who were not so fortunate as to meet him in person received a similar inspiration from his textbook, *Principles and Practice of Medicine*, first published in 1892,

which is still a standard work, having reached its 14th edition in 1942. One layman at least, F. T. Gates who had not previously been interested in medicine, was also inspired. "I read the whole book without skipping any of it. I speak of this not to commemorate my industry or intelligence but to testify to Osler's charm, for it is one of the very few scientific books that are possessed of high literary quality. There was a fascination about the style itself . . . that pulled me from page to page. . . until the whole of a thousand large and closely printed pages brought me to the end. There were other things besides its style that attracted and intensified my interest. . . . To the layman student, like me, demanding cures, and specifics, he had no word of comfort whatever. In fact, I saw clearly from the work of this thoroughly enlightened, able and honest man, perhaps the foremost practitioner in the world, that medicine had—with the few exceptions above mentioned—no cures, and that about all that medicine up to 1897 could do was to suggest some measure of relief, how to nurse the sick, and to alleviate in some degree the suffering. . . . When I laid down this book I had begun to realise how woefully neglected in all civilised countries and perhaps most of all in this country, had been the scientific study of medicine. . . . It became clear to me that medicine could hardly hope to become a science until it should be endowed, and qualified men could give themselves to uninterrupted study and investigation, on ample salary, entirely independent of practice. . . . Here was an opportunity for Mr. Rockefeller to become a pioneer."

Gates was one of Rockefeller's philanthropic staff. Under this inspiration he wrote a memorandum which led to Rockefeller's great medical endowments. Such was Osler's faculty for inspiring others—a faculty that could still produce vast effect at second or third hand.

Osler was no narrow specialist, but an all-round scholar with wide and deep literary interests. In the last year of his life at Oxford (whither he had migrated in 1904) he became President of the Classical Association. But more than that, he was an all-round man. How can one express in a paragraph a many-sided humanity which it took Cushing 1400 pages to describe? Perhaps it is best to single out his puckish sense of humour, which is closely connected with his success as an inspirer. Of practical jokes he never tired. Two members of the Athenaeum saw them in very different lights: "The way he would slap you on the back, and pick your tail pockets while you were reading the telegram was delightful", says one; but the other felt that it was "undignified of Osler to secretly insert bulky objects in one's coat-tail pocket while leaning over the umbrella-stand harmlessly deciding upon one's own property". During his bedside teaching he spouted epigrams. Some were medical, like "Probability is the rule of life—especially under the skin. Never make a positive diagnosis," or "The mental kidney more often than the abdominal is the one that floats." Some referred to wider aspects of life: "Believe nothing that you see in the newspapers—they have done more to create dissatisfaction than any other agencies. If you see anything in them that you know is true, begin to doubt it at once." The last looks like the cynicism of the ivory-tower scientist, who sees only dirt beyond his threshold. But it was not so with Osler. It was humanity and social service that inspired his work.

Such a character can easily fade as time passes. Because

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his greatness depends so much on the pastel shadings of personal contacts, it is too easy for posterity to note that his published works are good but not great, and thence to conclude that his contemporaries suffered from an optical illusion when they valued him so highly. Only a good biographer can save such a man from such a fate, and future generations will rejoice that Osler found his Boswell in Harvey Cushing. Cushing's *Life of Sir William Osler* has already become a classic, which ought to be read by every medical student and, indeed, by anybody who desires to understand the relations between a great physician and the community for which he worked.

Science and Traffic Problems

"THERE is a fashion for one-way traffic systems today and it might almost seem that no town can be considered worthy of its name unless the traffic passing through it is compelled to gyrate. Gyrotory systems of traffic are often a source of considerable inconvenience and expense to local residents, however, and there is no point in paying except for benefit received." So said Mr. G. T. Bennett in a paper recently delivered at the Institution of Civil Engineers on the subject of scientific research on traffic problems. He was commenting on the results which Dr. R. J. Smeed had reported in another paper concerning studies which the Road Research Laboratory had carried out on a one-way system tried at Slough. To a casual observer, no doubt, this particular one-way system would have looked successful, for he would have seen the traffic moving 25% faster in one direction and with undiminished speed in the other. But half of it had to move over a longer route, and its average journey time was increased from 102 to 148 seconds, so that although the average journey time in the other direction was reduced from 123 to 99 seconds, nevertheless the net result was an increase in 22 seconds in the time for the double trip.

Apart from showing that one-way traffic systems may be less beneficial than they seem, this illustrates the more general point that in the present state of knowledge there is usually no satisfactory method of predicting what effect changed conditions will have on the movement of traffic. The main method of research at present must be through 'Before-and-After Studies'—observe how the traffic behaves, make some change in the conditions, then observe again how the traffic behaves, draw your conclusions and so reach a decision to retain, abolish or modify the changes.

An interesting before-and-after study was carried out by the Road Research Laboratory on the effect of the 1947 Order which forbade waiting, loading and unloading, and unlicensed street-trading in certain London streets between 11.30 a.m. and 6.30 p.m. Four routes were selected for study and three methods of observation were used on them. Cars were driven along the routes, their times of passage between certain points and the times during which they were stationary being recorded. A census of vehicles was carried out. And aerial photographs were taken at two-second intervals, from which it was possible to deduce



Sir William Osler at work on his great textbook (from *Life of Sir William Osler*, by courtesy of Humphrey Milford).

such things as the average speeds of vehicles and average distances between them. It was discovered that the flow of vehicles (the number of vehicles passing a specified point in unit time) was not appreciably affected by the new regulations. Though Dr. Smeed did not draw any conclusion from this, we might hazard the guess that it means that even the greater congestion before the changes was not effective in deterring motorists from using the routes; in other words, that no alternative routes in existence were capable of being used instead of the ones under investigation for such purposes as their normal users had in view. There were very significant improvements in the average journey speed, ranging up to 25% and averaging 10%, even if allowance is made for the fact that not all the saving in man-hours represents real economic gain, nevertheless the economic benefit arising from the new regulations is very considerable.

In a much more ambitious research, the Laboratory surveyed traffic conditions on some 36 miles of London streets, including most of the main thoroughfares. The survey was done by using cars which infiltrated into the normal stream of traffic and behaved as if they were ordinary vehicles. Observers in the cars noted the relevant data, such as journey times between various points, time lost in stoppages, numbers and types of vehicles which were met moving in the opposite direction.

Among many other things it was found that on an average 41% of vehicles passing through a controlled intersection on a main route during the busy times were stopped. They were stopped on an average for 29 seconds and lost a further 15 seconds in slowing down, pulling up to the next vehicle, waiting for a chance to turn, and accelerating. This gives a loss of 44 seconds per time stopped and 18 seconds per intersection passed. On the average a vehicle had to stop 2.3 times and lost 1.6 minutes per mile. The average journey speed over these routes was 11.1 miles per hour. If this could be doubled, these routes alone would give a saving of 13,000 man-hours per hour.

Maps accompanying Dr. Smeed's paper give a summary of traffic flow and speeds. The flow reaches as high as

1500 vehicles per hour moving west and 1220 moving east in the western part of Piccadilly. Here the average speeds are 15.2 miles per hour westward and 8.0 miles per hour eastward. But these are somewhere near top speeds for central London, and at the other extreme we find several streets in the City where the speeds are only 4 or 5 miles per hour. To anybody who has seen traffic circulating comfortably at some 30 miles an hour in many main streets in Paris, or who has sat in the Champs Elysées and watched cars moving at 70 miles per hour and passing others that seemed to be crawling at a mere 40, these figures are appalling; and certainly very radical measures will be required to make London a city in which one can move comfortably and economically.

Investigations of speed and flow are far from exhausting the work being done by scientists on traffic problems. For example, many experiments have been carried out to determine the most conspicuous surface markings for pedestrian crossings. The best marking was found to be a zebra pattern, of alternating black and white stripes, about two feet wide and running parallel to the kerb. Some districts are already benefiting from this finding.

Obviously much of this traffic research is still in an elementary stage. In Britain it only began seriously in 1946. But at least those concerned have shown themselves to be alive and to be ready to adopt any good technique. The use of aerial surveys mentioned above is a good example. Various types of traffic counters have been designed and extensively used. The behaviour of drivers following closely behind one another has been investigated, both on the road and in specially controlled experiments on a disused airfield where drivers were observed while playing a sort of follow-my-leader game. Sampling and census techniques have been evolved for discovering such matters as the destinations to which traffic is proceeding. And—to step for a moment outside the work of the Road Research Laboratory—readers will remember the brilliant opportunism of the Automobile Association, which turned the heavy snowfalls of early 1947 into a research instrument by photographing the traffic tracks in the snow and so demonstrating very vividly many weaknesses in road layout (see *DISCOVERY*, April 1947, p. 101). Dr. Smeed points out that the Road Research Laboratory can develop methods of research, but that it has facilities to apply them in only a very small number of cases. He appeals therefore for co-operation from local authorities. If they will use these methods, they will obtain benefits in relation to their own traffic problems; and if they will contribute their results to a common pool for the Laboratory to analyse, they may help in something much greater.

New Lamps for Old!

IN the November 1945 *DISCOVERY* a brief description taken from the *History and Memoirs of the Royal Academy of Sciences* of Paris for the year 1700 was given of the first record of man-made luminescence in a gas—the glow to be

observed above the mercury in a barometer when it is shaken. The recent announcement that a patent had been taken out in the U.S.A. (No. 2,449,880) for a lamp consisting of an evacuated bulb coated internally with a fluorescent material and containing some argon gas and a few drops of mercury, which lights up when it is shaken prompted us to refer again to that old discovery.

It appears that M. Bernoulli very closely anticipated the twentieth-century inventor. Here, in a contemporary translation, is his description of one of his experiments: "I entirely neglect the making of other observations upon the light of the barometer, since I have found a way to render the quicksilver luminous in a phial; which, in my opinion, is far more curious, as it furnishes a sort of perpetual phosphorus, and is convenient to carry about, besides that the light of it is much more lively than that of the barometer. Take a clear fair phial, strong enough to sustain the agitation of the quicksilver and place in it five or six ounces of quicksilver, well purified. Stopper the phial, before you draw out the air, with a cork and a proper wax over it and then make a little hole with a pin through the wax and cork, to give an opening to the air which you are going to draw out of the phial; this being done, enclose the phial in a receiver (the bell jar of an air pump), out of which the air must be drawn, as exactly as possible, to get it at the same time out of the phial by the aperture of the little hole; the greatest difficulty is how to close this little hole before you let any air get into the receiver. To perform this easily, you must expose the receiver, thus empty, to the sun, and with a convex glass melt the edges of the wax about the hole. In this manner the hole is filled with melted wax, and stops itself perfectly well of its own accord. Being assured that all is well done, let the air enter again into the receiver and take out the phial which, being thus prepared, serves then for a phosphorus whenever you will take the pains to shake the phial in the dark."

Bernoulli, who, in spite of the ingenuity of this technique, was chiefly noted as a pure mathematician, had a long explanation of the effect in terms of a "subtle matter which came out from between the pores of the mercury", which, when rewritten in modern terms, is astonishingly close to the truth of the matter. In fact what happens is that when the tube is shaken the mercury rubs over the glass surface and electrifies it just as silk and glass are electrified by friction. A potential difference builds up between the mercury globule and the glass wall, and eventually a discharge occurs through the mercury vapour which pervades the vessel, causing a flash of light. Under these conditions of low pressure (identical with those in a fluorescent lamp) most of the energy radiated by the mercury discharge is in the ultra-violet range, and so the brightness of the flash is enhanced if a fluorescent material is placed inside the tube. It is doubtful, however, whether the increased quantity of light so obtained will remove the invention from the field of scientific curiosities. Certainly any lamp based on the American patent is unlikely to put the glow-worm in the shade!

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Pioneer of Hydrogenation

E. M. FRIEDWALD

TODAY it is the physicist who is the prima donna on the stage of science. But only yesterday it was the chemist. For nearly half a century he held the spotlight, ever since the potentialities of chemistry in reproducing artificially the products of nature became the great industrial reality of the twentieth century. And in spite of the spectacular advent of atomic energy and the hold it has taken on popular imagination, the fact remains that we are still living very much in the century of synthetic cotton and silk, of synthetic oil and rubber, of synthetic dyes and perfumes, of synthetic fertilisers and foodstuffs, even of synthetic vitamins and hormones.

Indeed, it is enough to reflect how much these new products have shaped our everyday life to realise to what extent we still live in the age of chemical synthesis—or, to be more exact, of catalytic synthesis. For most of the synthetic processes of chemical manufacture which account for the tremendous growth of the chemical industry in the last fifty years would be impossible or impracticable without resort to the use of catalysts. Indeed, it was the remarkable development of catalysis started at the end of the nineteenth century which lifted chemical synthesis out of the laboratory into large-scale industry.

The mechanism by virtue of which certain chemical reactions are caused or accelerated by substances which do not appear to take any part in the reactions was first observed scientifically by Kirchhof in 1811. The actual term 'catalysis' was coined by Berzelius in 1836. The known cases of catalytic action increased in number during the nineteenth century, but they were of academic rather than practical interest. The investigations of the French chemist Paul Sabatier, started in 1897 and pursued for some thirty years, opened a new era in catalytic chemistry. And it was his work more than anything else which transformed what was largely a phenomenon of the laboratory into one of the most potent forces which revolutionised modern industry.

Although Sabatier's work ranged over general, inorganic and organic chemistry, by far the most important of his achievements sprang from his investigations of catalysis in organic chemistry, more particularly of catalytic hydrogenation of organic compounds. He showed that certain finely divided metals—nickel in particular, but also cobalt, iron, copper and platinum—are remarkable catalysts of universal application in hydrogenation reactions. He also studied catalytic reactions other than hydrogenation, and revealed the catalytic power of a number of substances, notably that of thoria. With the help of his pupils, amongst whom the Abbé Senderens, Mailhe, Murat, Espil and

Gaudion deserve particular notice, he effected several hundred different reactions, most of them hydrogenations and dehydrogenations. For he soon found that the same catalysts which promote the former are no less effective for the latter.

One of Sabatier's most illuminating contributions lies in his discovery of directive or selective catalysis. For example, the decomposition of formic acid can be directed either towards carbon dioxide and hydrogen, by using metals as the catalyst, or towards carbon monoxide and water, by using dehydrating oxides as the catalyst. This discovery followed logically from Sabatier's ideas about the mechanism of catalytic action. Contrary to the then prevalent physical theory of catalysis, he believed in the chemical theory which he helped to develop. He held that in all cases the catalyst combines chemically with one of the agents or the products of the reaction to form a temporary unstable compound which serves as an intermediate step in the reaction. It follows therefore that it is the chemical nature of the catalyst which determines the direction of the reaction.

He was also the first to pay attention to what are now called *promoters*, that is, substances which, added to the catalyst, increase its efficiency.

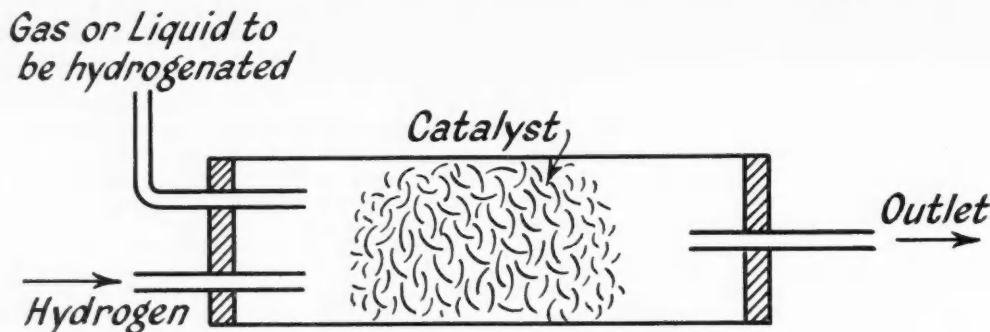
One of the most remarkable features of Sabatier's research was the surprising simplicity of the apparatus used. This consisted of a glass or quartz tube forming the reaction space, in which was placed a layer of the catalytic agent. One end of the tube was closed with a stopper carrying two inlets, one for the hydrogen, the other for the liquid or gas to be investigated. The other end of the tube was closed with another stopper carrying an outlet for the product of the reaction. It was with this simple apparatus that Sabatier evolved his general method of catalytic hydrogenation which will for ever represent an important chapter in chemistry.

Apart, however, from their importance to pure science, these investigations had far-reaching practical results, both direct and indirect.

Directly, they led to unexpected industrial applications. In the fine-chemical industry they resulted in simple processes for the manufacture of numerous compounds, such as acetic acid and acetone. The most important direct outcome of the catalytic hydrogenation method, however, was the establishment of the great industry concerned with the hardening of oils which is, particularly at the present time, of such vital importance for the manufacture of margarine and soap. Vegetable oils and animal fats which are liquid at the ordinary temperatures differ from solid fats (which are the raw material for the manufacture of



DR. PAUL SABATIER.



This diagram shows the apparatus used by Sabatier in his research into catalytic reaction.

soap and margarine) in that they contain less hydrogen. And the only practical way of converting these liquid oils into solid fats is hydrogenation in the presence of finely divided nickel. The bulk of the margarine consumed in the world today is the direct result of the industrial application of the Sabatier method.

Another important result of this method was the development of catalytic hydrogenation processes for the refining of petroleum and the manufacture of high-grade fuels and lubricants.

But perhaps even more far-reaching than these direct consequences was the indirect effect which Sabatier's work had on the general development of catalytic processes in industry. By effecting over 200 different hydrogenations by one method alone, the French chemist revealed the great fertility of catalytic methods and opened the eyes of other researchers to the vast possibilities of catalysis in the field of industry. It was no accident that, a few years after Sabatier published his first results, Ostwald began his investigations into the catalytic oxidation of ammonia, and Haber his research on the catalytic synthesis of ammonia, both of which led to the establishment of the great industry of fixation of atmospheric nitrogen.

Nor can there be much doubt about the stimulus which Sabatier's work gave to the development of the industrial processes for the manufacture of synthetic petroleum products. Actually Sabatier himself synthesised the main types of petroleum (the Pennsylvanian, the Caucasian and the Galician) by condensation and hydrogenation of acetylene in the presence of nickel at different temperatures.* Even though this method did not lend itself to industrial exploitation, it undoubtedly stimulated the development of the Bergius and the Fischer-Tropsch

* Actually this synthesis led him to propose a theory of the origin of petroleum. He assumed that the alkaline metals (sodium, potassium) and their carbides in the depth of the earth, by coming into contact with water, produce respectively hydrogen and acetylene. These in their turn come into contact with nickel, cobalt, or iron, in a finely divided state and at an elevated temperature, and there follows condensation and hydrogenation of acetylene which leads to the production of petroleum hydrocarbons.

But Sabatier did not exclude other theories of the origin of petroleum. He was not a dogmatic believer in the indestructibility of theories in general, not even of the chemical theory of catalysis which had guided him throughout his work. Like Henri Poincaré, he held that "a theory is good only as long as it is useful", and should be abandoned as soon as it becomes irreconcilable with well-established facts.

processes. The first consists in the catalytic hydrogenation under pressure of coal made into a paste with heavy oil, the second in the catalytic hydrogenation of carbon monoxide. Both are the logical continuation along the road opened up by Sabatier, particularly the Fischer-Tropsch process which started from the classic reaction of Sabatier and Senderens, the hydrogenation of carbon monoxide into methane over nickel.

In a sense, Sabatier himself acted very much like a catalyst in speeding up considerably the development of catalytic methods. His discoveries have had enormous industrial consequences and he must be considered as one of the founders of modern catalytic chemistry.

Paul Sabatier was born at Carcassonne—that strange and unique town where there is to be found a fully preserved medieval city nearly 1000 years old—on 5 November 1854. He attended the *lycée* of his native town and later that of Toulouse to prepare for the competitive entrance examinations to the *Ecole Polytechnique* and the *Ecole Normale*. These, by far the most difficult of the *concours d'entrée* to the great schools of France, he passed successfully at the age of twenty, taking eighteenth place for the *Polytechnique* and fourth for the *Normale*. He chose the latter and three years later graduated as *agrégé des sciences physiques* at the top of the list. This distinction meant that it would not be long before he would become a member of the Faculty.

First, however, he spent a year as professor of the *lycée* at Nîmes. Then he went to Paris to work as assistant to the great Berthelot at the *Collège de France* and while there prepared his doctorate thesis—on metallic sulphides—which he presented in 1880. Immediately afterwards he was offered and accepted the readership in physics at the University of Bordeaux, and a little later transferred to the same position at the University of Toulouse where, at the age of thirty, he became professor of chemistry.

Until that time, and indeed for another dozen years, his main interest lay in general and inorganic chemistry—no doubt the consequence of having worked in those branches first under Henri Sainte-Claire Deville at the *Ecole Normale*, then under Berthelot at the *Collège de France*. As he himself admitted later, he would have been astonished if during the first twenty years of his career he had been told that by far his most important achievements would lie in the field of organic chemistry. He sometimes used to reminisce to his older pupils on how he first was drawn

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towards the study of catalytic reactions, a story which he retold to the American Chemical Society at Cincinnati in 1926.* His account is interesting if only for the light it throws on the anatomy of scientific discovery.

The starting-point of Sabatier's investigations into catalytic hydrogenation was the observation made in 1890 by Mond, Langer and Quincke, that finely divided nickel or iron, prepared by reduction of their oxides, combined with carbon monoxide, forming nickel or iron carbonyl. (This observation led directly to the establishment of the Mond process for the extraction of pure nickel.) This prompted Sabatier to investigate whether other unsaturated molecules of gas could be fixed in the same way on nickel or iron. The experiments, carried out with the help of Jean-Baptiste Senderens, with nitric oxide and nitrous oxide, were negative, but it was found that nitrogen peroxide could be fixed on freshly reduced copper.

These experiments were completed in 1896, and Sabatier was about to attempt the fixation of acetylene on the same metals when he learned from the *Comptes rendus* of the Academy of Sciences that the experiments he had in mind had just been made by Moissan and Moureu. These two scientists had found that the action of acetylene on iron, nickel or cobalt (freshly obtained by the reduction of their oxides by hydrogen) resulted in a rise of temperature which brought about the decomposition of the greater part of the acetylene into carbon and hydrogen, and the polymerisation of the remaining acetylene into liquid products consisting mainly of benzene and other cyclic hydrocarbons. They believed that the porous metal absorbs acetylene with production of heat sufficient to cause incandescence of the metal and subsequent destruction and polymerisation of the acetylene. But they thought so little of this reaction that they neglected to analyse more thoroughly the gaseous and liquid products of the reaction. Had they done so, they would have found only a little hydrogen and a large proportion of saturated hydrocarbons. Moreover, had they taken the precaution of eliminating the hydrogen after reducing the metallic oxides, they would have found that a flow of acetylene did not produce spontaneous incandescence at ordinary temperature.

Sabatier, however, though realising that there was little hope of 'fixing' acetylene on nickel, was far from satisfied by the purely physical explanation given by Moissan and Moureu of what seemed clearly to be a catalytic reaction. Believing in the chemical theory of catalysis, he saw the cause of the phenomenon in the chemical affinity of the metal either for acetylene or for the carbon or hydrogen which issue from its decomposition. At all events he thought of taking up these experiments, and having learned that Moissan and Moureu did not intend pursuing them, decided in 1897 to start, not with acetylene, but with ethylene, which is less violent in its reactions. He still expected a fixation of ethylene on nickel, resulting in a compound similar to nickel carbonyl.

But when with Senderens he directed a flow of ethylene on reduced nickel there was no action until the temperature was raised to 300°C. At that point the nickel became brilliantly incandescent and there was decomposition of ethylene into its elements, hydrogen and carbon, the latter

forming a voluminous deposit. But the gas issuing from the tube contained only a little hydrogen and consisted mainly of ethane. Clearly, the latter could only have been the result of the hydrogenation of that part of the ethylene which had not been decomposed, and this hydrogenation had undoubtedly been provoked by the presence of nickel. This the two scientists immediately verified, passing a mixture of equal volumes of ethylene and hydrogen over reduced nickel. They found that, at a temperature of 30° to 40°C., pure ethane was obtained and that the same catalyst could be used indefinitely.

The following year they found that reduced nickel, and to a lesser extent finely divided cobalt, iron, copper and platinum, also had the same power as a hydrogenation catalyst with respect to acetylene. At ordinary temperature, acetylene could be hydrogenated into either ethylene or ethane, according to the proportion of hydrogen used.

The question then arose whether this catalytic power of nickel was general, and the two scientists proceeded to the decisive test, viz. the conversion of benzene into cyclohexane, a particularly difficult case of hydrogenation which had previously never been realised. The test was completely successful, and thirty years later Sabatier still remembered the drama of the moment when he started the experiment, the despair he felt when it seemed that the reaction was not proceeding at all, and the delight he experienced when, on opening the tube, he perceived the characteristic smell of cyclohexane.

Actually he was fortunate in that both the catalyst and the benzene and hydrogen used were pure. Had they been contaminated by traces of catalytic 'poison'—such as chlorine, bromine, iodine or sulphur compounds, which are 'toxic' to catalysts—there would have been no hydrogenation, and the experimenters, unaware at the time of the extreme susceptibility of the nickel catalyst to traces of 'poison', might have concluded that this particularly difficult hydrogenation could not be achieved with nickel. Incidentally, this was the first time that pure cyclohexane had been isolated.

The universal power of nickel as a catalyst of hydrogenation was as good as established and all that remained was to verify it for various kinds of compounds.

The way in which Sabatier, using finely divided metals, came to discover catalytic hydrogenation provides a perfect illustration of how scientific discoveries of great practical importance for industry are often made almost accidentally in the pursuit of science for its own sake. For Sabatier set out to study *not* catalysis, still less catalytic hydrogenation, but to investigate the possibility of fixing unsaturated molecules of gas on nickel and iron; and it was in the course of these investigations that he stumbled across the catalytic power of finely divided metals. And the fact that he perceived what had escaped as famous an experimenter as Moissan does not make his discovery any the less accidental.

Nor was his subsequent research influenced to any extent by considerations of its industrial usefulness. The discovery once made, Sabatier set out to investigate systematically and meticulously the catalytic hydrogenation of organic compounds. But the very leisuredness with which these investigations were carried out over a period of nearly thirty years shows that he was not unduly concerned about the commercial applications of his discovery.

* "How I have been led to the direct hydrogenation method by metallic catalysts", *Ind. & Eng. Chem.*, October 1926, pp. 1005-8.



FIG. 1.—How the actor sees the studio. Between two cameras stands the studio manager giving a cue to start, while engineers bring up lights or adjust the microphone.

FIG. 2.—The cameraman's view of the artist. The viewfinder on the side of the camera shows an upside-down image which must be kept continually in focus. The producer's instructions are given to the cameraman through the headphones he is wearing.

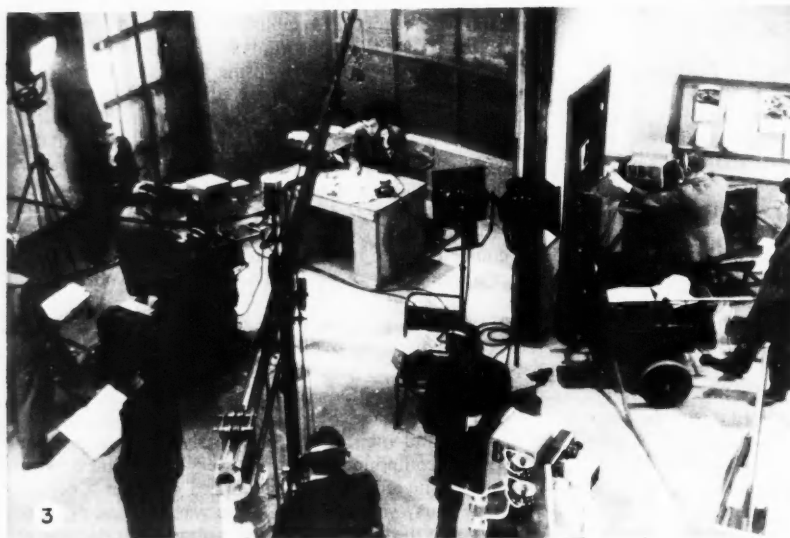


FIG. 3.—A scene on the studio floor, seen from above. Two cameras are trained on the actor at the desk. Note the microphone suspended from the boom in the foreground.

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British Television

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TELEVISION is not, as is popularly supposed, the invention of one industrial firm, or even of one man. It is rather the realisation of the ambitions of scientists over nearly 100 years in which many inventions have played a part and to which contributions have been made from every country. The fundamental discoveries were made by a Frenchman and a German. The basis of the modern system is due to an Englishman and a Hungarian, and the practical application was made by a Russian. America has contributed improvements in technique, and the experiments of radio amateurs all over the world provided information for the successful transmission and reception of television on short wave-lengths.

Nevertheless, among the outstanding contributions to television development the names of British scientists are prominent, and no account of its development would be complete without reference to the pioneers Campbell Swinton, Baird, and later, Blumlein, McGee, and many others who have collaborated in producing the world's first successful commercial television system.

Basic Principles

The fundamental phenomenon on which television depends is the conversion of light energy into electrical energy by means of the so-called photo-electric effect. This was first noted by Becquerel in 1839 and later applied in a practical form to the photo-electric cell made by Elster and Geitel in 1890. The photo-cell provides a means of directly converting light of a given intensity into a current of corresponding intensity, and thus provides the main link in all systems of transmitting pictures by radio or wire over a distance.

The photo-cell is, however, only the basis. The scenes which continually meet the eye are composed of an infinite variety of light values, ignoring the special characteristic of colour, but the photo-cell can only respond to one value of light intensity at any one instant. To translate a complete scene, therefore, it is essential that it is presented to the photo-cell as a series of units of light value, each unit being converted into its equivalent pulse of electrical energy. This systematic sub-division of the scene into discrete elements of light intensity is known as *scanning*, and it is the necessity for scanning which constitutes the major difficulty in transmitting scenes by television with the same degree of quality as the original.

At the receiving end of the system the sequence of electrical impulses is converted into light impulses of the correct intensity, which are then reassembled on a screen to constitute the original scene. This scanning and reassembling process has reached a high degree of perfection in the transmission of still pictures by wire or radio, and the study of a telephotography system provides a very

good insight into the principle of operation of the early television systems.

The picture to be transmitted is wrapped round the circumference of a drum, which rotates at about 60 revolutions per minute while a fine pencil of light is reflected from its surface on to a photo-cell. The drum also moves continuously in an axial direction, so that the pencil of light eventually covers the whole surface of the picture in a series of parallel lines as the drum rotates. The fluctuating current generated in the photo-cell by the passage of light and dark portions of the picture under the light beam is amplified and sent to the receiver, where it modulates the intensity of a similar light beam which traverses a sheet of photographic paper rotated in synchronism with the transmitting drum. The original picture is thus reproduced on a groundwork of fine lines which are sufficiently close to be imperceptible.

The amount of detail which is transmitted is clearly governed by the smallness of the spot of light and the axial pitch of the drum movement, and satisfactory pictures are obtained by 100–150 lines per inch. At one revolution per second, the time taken to transmit a complete picture is thus about 15 minutes.

The principle of scanning was applied to the transmission of moving scenes by Nipkow, who used a rotating disk perforated with a series of holes arranged in a spiral. His receiving system was noteworthy in that it utilised the property of a magnetic field in controlling the intensity of light passing through a block of flint glass. Nipkow's system, like many other schemes of the '80's was not of commercial value, but it paved the way for a later and more successful attempt.

Twentieth-Century Developments

The turn of the century saw two scientific achievements which made a complete change in the prospects of accomplishing practical television. In 1904 Fleming invented the thermionic valve, later improved by Lee de Forest in America, and about the same time the cathode ray tube

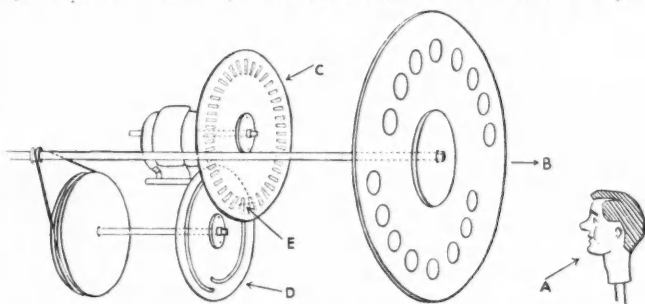


FIG. 4.—Diagrammatic sketch of J. L. Baird's first television scanning system in which a dummy head (A) was scanned through a rotating lens disc (B) and spiral slots in the disc (D). The apertures E in the disc C served to interrupt the light to give a pulsating signal.

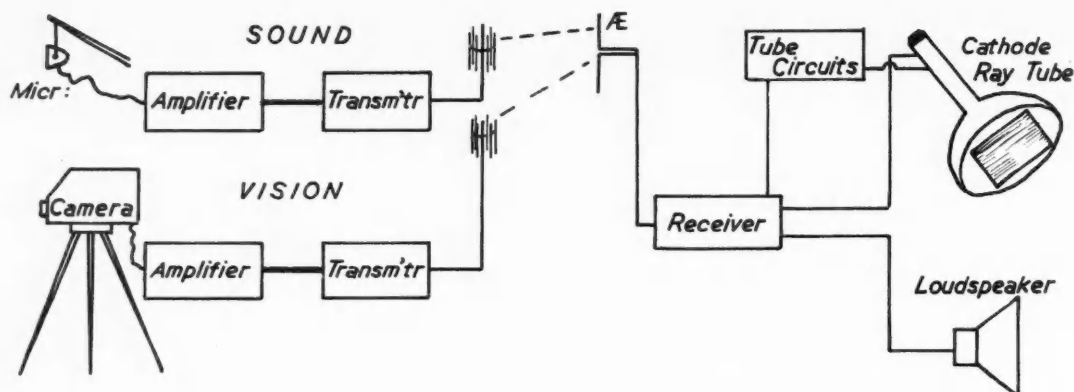


FIG. 5.—Diagram of television system showing separate sound and vision channels at the transmitter. Both signals are received on one aerial AE and separated in the receiver circuit. The picture appears on the screen of the cathode ray tube, which is supplied from a separate power source.

emerged from the experimental laboratory. The thermionic valve solved all the difficulties of amplifying and transmitting the minute photo-electric currents and the cathode ray tube provided a means of producing a flexible light beam which could easily be controlled in intensity.

The idea of using the cathode ray tube for the scanning and reproduction of television pictures occurred almost simultaneously to Boris Rosing and Campbell Swinton. The latter is usually given the credit for propounding in a letter to *Nature* the details of a system on which the present-day transmission is based. He conceived the idea of a mosaic screen made up of a large number of photo-electric elements, on which the image of a scene could be focused. The 'photo-electric image' was then scanned by a beam of cathode rays and a varying current would be drawn from it, depending on the degree of illumination to which each element of the mosaic had been subjected. A cathode ray tube was used at the receiving end to reproduce the image, and arrangements were made to keep the transmitting and receiving scanning beams in step.

Campbell Swinton realised the practical difficulties in such an arrangement, but his scheme provided the stimulus for fresh experimenting on scanning methods which were brought to a successful outcome twenty years later.

After the First World War the development of the thermionic valve led to efficient multi-stage amplifiers, and the problems of television were again attacked by Mihaly (Hungary), Jenkins (America) and Baird (England).

J. L. Baird

It is the name of J. L. Baird which is associated with television development in England more than any other, and rightly so.

With little technical background, this unknown Scottish inventor succeeded in 1924 in demonstrating that television was a practical proposition. His first crude apparatus, which was publicly shown in 1926, was based on the Nipkow disk principle, the light reflected from a dummy figure being focused on to a photo-cell through a series of

lenses arranged in a spiral (see Fig. 4). For reproducing the picture he used a similar disk with small holes, rotating in front of a neon lamp. The received signal caused fluctuations in the intensity of the lamp, and a flickering picture of orange-red colour could be seen through a magnifying lens in the receiver.

The single-mindedness and intensity of Baird's early work cannot be over-estimated. After his first demonstration he patented in quick succession systems for colour television, stereoscopic television, television in the dark ('noctovision'), and finally gave the first demonstration of large-screen television at the Coliseum theatre in 1930. Although many of his earlier inventions were superseded by later improvements he devoted his life to the subject and within a few years of his death in 1946 he had developed a successful method of colour television using a cathode ray tube which is now being perfected in America.

Although Baird's demonstration of working television in 1926 led to an experimental transmission of pictures by the B.B.C. four years later, it was recognised that any future development lay in the electronic side rather than in the electro-mechanical systems using rotating disks or drums. The cinema had set a standard by which moving pictures were consciously or unconsciously compared, and to achieve the same degree of detail and overall quality of reproduction the number of scanning lines would have to be increased to a figure beyond the capacity of simple mechanical systems. The original Baird system utilised only 30 scanning lines per picture, which limited its field to close-up shots and crude contrasty scenes, and experiments showed that at least 400 scanning lines would be required to give adequate detail.

The Electronic System

In 1933 Vladimir Zworykin, now Director of Research of the Radio Corporation of America, patented a television camera which he termed an Iconoscope, the operation of which was based on Campbell Swinton's cathode ray tube camera. At the same time independent research

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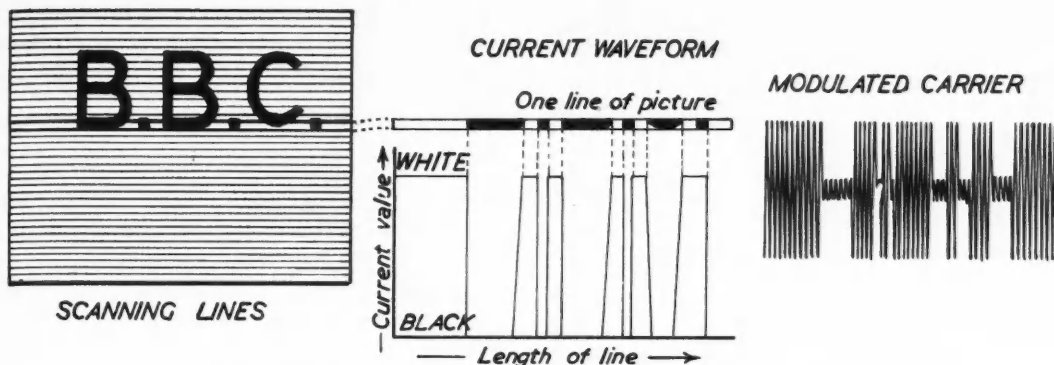


FIG. 6.—To illustrate the principle of scanning. The picture is divided into strips or lines, one of which is shown separately in the centre. The values of light intensity along the line are converted into current values as seen in the graph, maximum current corresponding to the brightest portions of the line. The radio-frequency carrier wave is then modulated by the current and appears as shown on the right.

was going on in the laboratories of Electrical and Musical Industries Ltd. in England, culminating in an all-electronic television system of 405 lines using a similar type of camera, the Emitron. After a short trial period by the B.B.C., during which transmissions took place on alternate standards of 240 lines (Baird Company's system) and 405 lines (E.M.I. system), the British transmission standard was finally settled at '405 lines 25 pictures per second interlaced' and it is this system which is in use at the present time. The doubt is still expressed whether the present system is permanent and whether it will not be ultimately replaced by one employing a greater number of lines. While such an improvement would undoubtedly lead to better pictures, the practical and economic difficulties are such that it will be many years before it is put into effect.

To allay any doubts which might lead the public to defer buying television receivers, the Government have recently issued a statement reiterating that there is no intention of changing the present system for a considerable time, and even when the improved system is ready for commercial use an 'overlap' period will enable owners of existing receiving sets to obtain full value for their money.

The London Station of the B.B.C. is situated at Alexandra Palace, which stands on a hill in North London, 660 ft. above sea level. On the south-east tower of the Palace an aerial mast 300 ft. high has been erected to carry the aerials for radiating the vision signals and the accompanying sound.

The vision signal generated in the cameras is amplified and caused to modulate a radio frequency carrier wave in a manner similar to ordinary sound broadcasting. There is, however, one important difference. The circuit is so designed that the amplitude of the carrier wave radiated is proportional to the brightness of the picture at any instant, maximum amplitude corresponding to full white tone in the picture. When black (i.e. no light) is being transmitted, the carrier wave falls to a value about 30% of its maximum amplitude, and at the end of each scanning line it falls to zero for a short period, for reasons which will be seen later.

The advantage of this 'positive transmission' as it is called, is that the intensity of background illumination is

correctly rendered in addition to the light and shade of the scene itself.

The association of a definite light value with a definite amplitude of carrier wave provides a fixed level (the black level) to which the light-current relationship can be referred.

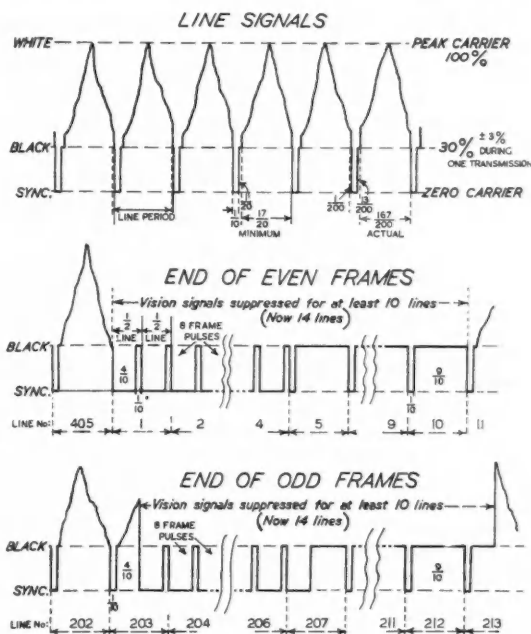


FIG. 7.—Waveform of vision signal radiated. Each line of the picture is followed by a short interval—the synchronising pulse. At the end of each set of lines (frame) a further series of pulses forms the "frame synchronising signal". The figures show the duration of the pulses in relation to the line period and indicate the precision required in scanning and synchronising the received picture.

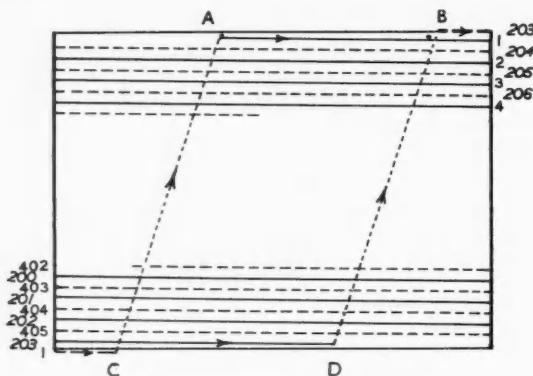


FIG. 8.—The path of the scanning beam in drawing an interlaced picture. The sequence of lines is marked by the numbers. Note that the line is broken at A, B, C, D to produce the interlace (see text for details).

Repetition Rate

In mentioning the number of scanning lines required for satisfactory reproduction, no mention was made of the picture repetition rate. Investigations in the photography of moving objects have shown that individual pictures must be projected on the screen at a minimum of 12–18 per second. Below 12 per second the persistence of vision of the eye fails to give the impression of continuous movement. At slow speeds of this order there is also an objectionable flicker, which was noticeable in the early days of cinematography. The projection rate of modern cine film is 24 frames per second, and accordingly a repetition rate* of 25 per second was considered convenient for television. This is a sub-multiple of the supply mains frequency (50 cycles per sec.) and is sufficiently near the cinema standard to enable films to be transmitted by television if desired.

Nevertheless, at this repetition frequency there is a certain flicker in the reproduced picture which is aggravated by the brightness and colour changes in the receiver screen. An increase to 50 pictures per second would improve the quality of the picture but would at the same time increase the technical difficulties of transmission.

An ingenious method of avoiding flicker without increasing the total number of pictures transmitted per second is that known as *interlacing*, or interlaced scanning.

In this, the scene is scanned with half the total number of lines ($202\frac{1}{2}$), in half the time of the picture repetition rate ($\frac{1}{2} \times \frac{1}{25}$ sec. = $\frac{1}{50}$ sec.). A gap is left between each line equal in thickness to one line. At the conclusion of this 'half-scan' (termed a 'frame') the scanning beam returns to the beginning of its travel and then traces a second set of lines in the spaces left between the first set. When the second set has been completed the whole picture has been scanned by 405 lines in $\frac{1}{25}$ second. The eye receives the impression, however, of two complete scans as it does not notice the second set of lines is slightly displaced, and the picture repetition rate appears to be 50 per second.

In any picture which is built up of a series of received impulses it is essential that a link is provided between transmitter and receiver to keep the scanning lines in step.

* Actually a repetition rate of 48 per second, as each frame is allowed to remain in the 'gate' for two openings of the shutter.

If, for example, the spot of light at the receiving end were lagging by half a line behind the transmitter the resulting picture on the receiver screen would be an unintelligible blur.

The link between the two scanning systems is provided by a synchronising signal which is sent out at the end of each line and each frame. At the end of each line a pause occurs during which the carrier current falls to zero, i.e. below the 30% level which is established for black. The pulse caused by this change in current is separated in the receiver from the vision signal and applied to the circuit which produces the scanning movement of the beam. The effect is to stop the movement of the beam and cause it to return to its original position to start another line, and at the same time the pulse is applied to the cathode ray tube to cut off the beam altogether during its return path across the screen. At the completion of the frame scan a series of longer pulses causes the beam to return to the start of the picture, and an extra pulse inserted after each 'odd' frame enables interlacing to take place.

The direction of scan in the present system is from left to right in the line direction, and from top to bottom of the picture.

Short Wave Transmission

It is interesting to consider the simple mathematics of high definition scanning at the rate which has been quoted. If each picture consists of 405 lines repeated 25 times per

second, the time occupied in scanning one line is $\frac{1}{405 \times 25}$ or $\frac{1}{10125}$ second. Assuming that the length of the line on the receiver screen is 8 in., the time to travel 1 in. is $\frac{1}{1265}$ second and a patch of light $\frac{1}{250}$ in. across will correspond to an impulse lasting only 1.6 microseconds.

In these days of precision radar an accuracy of one-millionth of a second is easily attained, but it should not lessen our wonder at a spot of light which can move ten thousand times across the screen in a second and respond to changes in intensity which last for less than a lightning flash.

The vision transmitter, therefore, has to handle a range of frequency from 25 per second to several million per

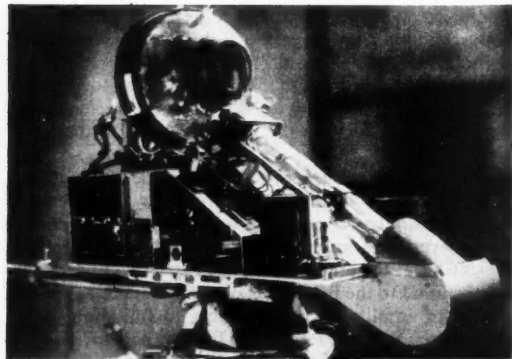


FIG. 9.—The Emitron camera with cover removed to show the tube and amplifier. The image is focused on a photo-sensitive mosaic at the back of the bulb and then scanned by a cathode ray beam from the electrodes at the front end of the tube.



FIG. 10.—A close-up of the Emitron camera's internal components, showing the tube and amplifier.

second, in the vision transmitter which is repeated 25 times per second. The frequency of the vision signal is 25 per second, the sound frequency is 50 per second, however, the vision signal is without ripple, short-wave and in certain cases the horizontal lines within 25–50 lines, although the evening colour is the West of

Transmission

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FIG. 10.—In the producer's gallery overlooking the studio through a window (right). The scenes taken by the cameras are viewed on the monitoring screens in front of the control desk.

second, in comparison with the sound broadcast transmitter which covers a range of less than 10,000 cycles per second. In order to accommodate such a wide range of frequencies, the so-called medium wave-band is useless, as the vision transmission would blot out the whole series of sound broadcasting stations. In the short wave band, however, there is room for a large number of transmitters without risk of interference. The drawback of using the short-wave band is that the transmission range is short, and in certain cases signals can only be received as far as the horizon. The area covered by the B.B.C. station is within 25–30 miles of the transmitter for reliable reception, although much depends on local conditions and intervening country. Freak reception has been reported from the West of England and as far south as the Isle of Wight.

Transmitting the Picture

A television studio resembles a film studio in layout and lighting facilities, but the special technique of taking scenes which cannot be repeated or edited calls for close co-operation between the production and engineering staff. The electronic cameras are under the control of a producer, who directs them during the taking of the scene while the cameraman adjusts the focus and position. The image of the scene is received on the photo-electric mosaic at the back of the Emitron and scanned by a beam of electrons in a similar manner to the movement of a beam of a cathode ray tube. The energy for deflecting the beam is provided and controlled by a master oscillator, which also provides the correctly timed synchronising impulses at the end of each line and frame. Four cameras are in use in the studio, and the outputs from these can be mixed or selected by the producer, who watches the outgoing picture on a monitoring receiver.

A film projector is also available, enabling full-length films to be included in the programme or short runs to be used in conjunction with the studio scene to give greater scope to the producer. The use of film mixed with 'live' transmission in this manner is unique to television and adds much to the presentation of certain plays.



FIG. 11.—The central control room, where the individual items from studio, film room, or outside broadcasts are blended to form the complete programme. The monitoring screens against the wall show the programme being transmitted together with "pre-views" of the other camera shots.

For televising outdoor events a highly efficient Outside Broadcast (O.B.) Unit is available. This comprises a mobile transmitter van, control room, aerial van, and generator. A special cable has been installed between the Alexandra Palace and certain strategic points in Central London and this is used for the direct transmission of signals wherever convenient. When the cable is not available the unit transmits the signal to an intermediate receiving point at Highgate, whence it is led to the Palace by cable. During the Olympic Games of 1948 the O.B. Unit created a record by transmitting scenes for a total of 68 hours in addition to the normal programme from the studio.

Receiving the Picture

The television receiver resembles an ordinary short-wave broadcast receiver in principle, but has several modifications to enable it to handle the wide band of frequencies transmitted. In addition to the vision and sound receivers, a separate pair of circuits provide the energy for deflecting the beam of the cathode ray tube. The tube itself has a screen 10 or 12 in. diameter, giving a picture approximately 8 by 6 in. or 9½ by 7½ in., and operates from a high tension supply of 5000–6000 V.

It is this high tension which introduces an element of risk into the television receiver, and the interior of the set should never be explored with the mains supply connected.

When no picture is being received the scanning lines are visible on the face of the tube, but the arrival of the carrier wave synchronises the scanning circuit with the vision impulses and establishes the 'black' level so that the intensity of the spot can be adjusted to this value. Two controls, which are unfamiliar to ordinary broadcast listeners, are provided. One, marked 'Contrast' alters the intensity of the modulation of the beam, and the other, marked 'Brightness' alters the overall level of illumination of the picture. The quality of the picture is thus within the user's discretion to a certain extent, although there is obviously an optimum adjustment corresponding to the

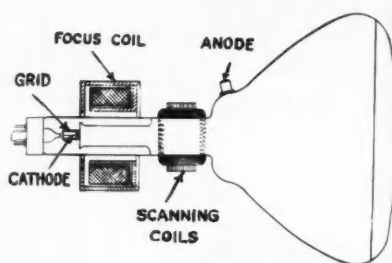
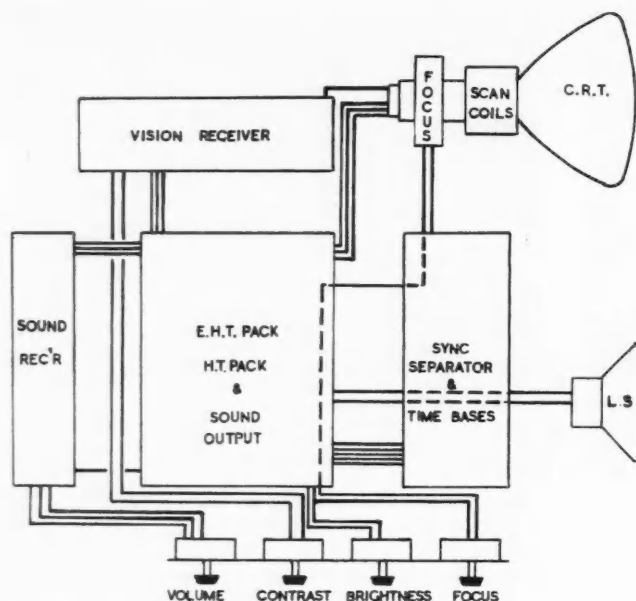


FIG. 12 (left)—Diagrammatic layout of television receiver with controls for varying quality of the picture. FIG. 13 (above)—Arrangement of electromagnet focusing coil and deflecting coils on a modern television tube. The incoming vision signal is applied to the modulating electrode (grid) of the tube.

ACKNOWLEDGMENTS.—Photographs of Figs. 1, 2, 10 by Behr-Hunot. Photographs 9, 11 B.B.C. copyright. Line drawings from *Electronic Engineering*.

light values transmitted from the studio. The sound volume is controlled in the usual way. A feature of the television programme is the high quality of the accompanying sound, which is transmitted with a wider band of frequencies than the ordinary broadcast sound.

At the present time programmes are radiated for a short period in the afternoon, commencing at 4.0 p.m., and in the evenings commencing at 8.30 p.m. A film is also transmitted in the mornings for test and demonstration purposes.

Future Developments

The B.B.C. Television Service, which was the first commercial service in the world to provide continuous programmes, suffered a severe setback during the last war when all transmission ceased. No resources or staff were available for maintenance, and on the cessation of hostilities the first requirement was the overhaul and improvement of the equipment to enable the service to reopen for the Victory Parade.

Plans made earlier for an extension of the service to the Midlands are only now being put into effect, but it is expected that an experimental service will be operating from a station at Sutton Coldfield late in 1949. This station will be linked with the London transmitter both by cable and short-wave radio link, and the relative merits of the two methods will be studied to determine the best method of extending the service to other provincial areas. The power of the Midlands transmitter is greater than that of London, and a wider coverage can be expected.

In reception of television, great improvements have been made in projection of large pictures. In an experimental cinema in South London a successful demonstration of large pictures was recently given by Cinema-Television

Ltd., the programme from the B.B.C. station being received and projected from a high voltage cathode ray tube mounted in a mirror projector. It is planned to link up certain cinemas to show outside broadcast scenes together with the film programme, a step which shows that television is not necessarily a rival to the cinema but a colleague.

While experiments have been undertaken from time to time in the field of colour television, the complexity and cost of the transmitter preclude any commercial developments in this for some years. On the whole it seems that the advances in the immediate future will be in improving the quality of the picture and in the range of reception.

Although the number of television licences will shortly reach the 100,000 mark, there are still many prospective viewers who are deterred by the suggestion that prices will come down, or that the system will be obsolete in a few years. The latter objection has already been referred to, and those who consider that the cost of the receiver is too high should reflect that the circuit is far more complex than that of the ordinary broadcast receiver. While the additional units are required for the reproduction of the picture it is hardly reasonable to expect vision and sound for the same price as sound alone.

Considered in terms of the entertainment provided, the modern television receiver represents a very good investment, and its performance is another example of high quality British design and construction.

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FIG. 1.—A British Sikorski helicopter spraying potato fields near Caen in a recent attack against the Colorado beetle menace in the Cherbourg peninsula.

(By courtesy of "The Times")

A New Era in Pest Control

D. STEWART MacLAGAN, D.Sc., F.R.S.E.

AGRICULTURAL and horticultural zoology are concerned with the application of zoological science to the businesses of farming and gardening, and few branches of applied science have made greater advances within the last twenty years. The services of entomologists and parasitologists are now eagerly requested by all progressive farmers and gardeners. Research and its applications have been the key to this sudden veering of opinion towards the men of science, and their recent contributions in the sphere of pest-control have certainly been remarkable. Indeed, modern insecticides and their practical developments may rank among the great agricultural 'discoveries' of our time. In some countries, practical men do not yet realise their full significance; but on the whole, the new insecticides are penetrating agricultural practice at a speed surpassing the dreams of the applied biologist and the ambitious salesman. These chemicals have actually inaugurated a new era in pest-control, reflecting novel ideas and methods, of which so many are now being adapted to enhance and cheapen the productivity of the soil. As an American scientist recently declared, "More good insecticides have been developed than science knows how to use efficiently and safely."

Natural Control

Whilst favourable climatic conditions are normally responsible for the sudden appearance of insect 'plagues', living enemies (in the form of predators and parasites) assist in checking the undue multiplication of insects.

Man cannot appreciably alter the climatic environment of insects, but he has powerful means of combating the pests by fostering their numerous natural enemies, such as shrews, moles, hedgehogs and insectivorous birds, in addition to the enemies of their own tribe—the parasitic and predaceous insects. Without these *natural* aids to pest-control—adverse weather, predators and parasites—man would harvest a meagre portion of the produce of the soil. Nevertheless, modern business conditions demand such a high standard of efficiency that special *artificial* aids to pest-control are welcomed. At one time, in the war against insect and allied pests, it seemed that the latter had a fair chance of success, but with the advent of potent insecticides like DDT, BHC, 1068, HETP, etc., man's control over the lower orders of life was never so powerful as it is today.

DDT

"This excellent DDT", as Mr. Churchill remarked in reference to the deadly action of this substance upon mosquitoes and lice, was first synthesised in 1874 by a student in the University of Strasbourg, but he never found out that the new compound meant death to insects. The 'discovery' of DDT—known to chemists as dichlorodiphenyl-trichloro-ethane—was made in its exploitation 66 years later by two Swiss scientists who used it in 1940, against the Colorado beetle. The potentialities and limitations of the 'penicillin of insecticides' are the subject of world-wide research, but enough is known to ensure that

its practical application will rank as a major contribution of science to the world. Production in America, for instance, has now reached the huge total of 2,000,000 lb. per month.

Many of the original claims made for this insecticide were without any sound scientific basis; and although experiments on the best formulations and application schedules are continuing, it is now possible to assess the true value of DDT as a pesticide. It is highly toxic to most insects, and the lethal dose is so small that there is no need to apply thick, unsightly deposits on foliage. A unique feature is its extraordinary persistency—so desirable in a contact poison, but not without some dangers. Fortunately, it is much less harmful to bees than was at first suspected, but no undue risks should be taken in this respect, e.g. spraying open blossoms. Used with discretion, DDT is probably the most generally useful insecticide at present available; and among the common crop-pests against which it may be recommended with confidence are: leatherjackets, cabbage caterpillars, blossom weevils, gooseberry sawfly, capsid bugs, flea beetles, winter moth caterpillars, tomato moth caterpillars, bean weevils, carrot fly, raspberry beetle, blackcurrant midge, pea moth, millepedes and woodlice. In America and Australia, it has proved to be particularly useful against the codling moth—a very serious pest of apples. A generally valuable feature of DDT is that it obviates the necessity of heavy annual sprays of arsenic in the orchard.

Against pests of livestock, DDT has also proved highly successful, particularly against lice, fleas, keds, blood-sucking and other flies. The common housefly is highly vulnerable to DDT, as also are the byre flies which pester cattle on warm sultry days. Lowered milk yields have been directly traced to these persistent pests, but anti-fly sprays of DDT on the walls of byres and stables are invaluable for bringing relief to the animals. The manure-heap should also be treated to counteract the breeding activities of the flies. In American cattle-ranches, where the fly nuisance is more serious than in Britain, the increase in production of meat has been astonishing; the average gain over unsprayed beasts being 50 lb. per head during the grazing season, in respect of 8000 head of cattle sprayed in Kansas. Throughout the sheep-countries of the world, correctly formulated dips and sprays of DDT are proving a godsend to the harassed flockowners in their struggle against maggot flies, ticks and keds.

Gammexane or BHC

Another 'wonder' insecticide of extreme toxicity to the majority of insects is benzene hexachloride, known to chemists as hexachlorocyclohexane ($C_6H_6Cl_6$), and originally synthesised in 1825 by Michael Faraday. Only recently was it discovered that, of the 4 isomers of this compound, the *gamma isomer* is by far the most toxic to insects. For many species it is the most powerful synthetic insecticide known to science, although of slightly poorer residual action than DDT. In Britain, spectacular results have been achieved against leatherjackets, wireworms, flea beetles and blossom weevils; as little as half a pound per acre of gamma-isomer giving greatly increased yields of cereals and sugar beet on land heavily infested with wireworms. Results have also been particularly good with reseeded pastures, which are often devastated by

wireworms and leatherjackets. Abroad, it appears that the age-old menace of locust-plagues may at last be eliminated by this potent insecticide.

Equally remarkable results are being obtained in the control of livestock-pests and insect carriers of human diseases. For example, the mange of sheep, caused by a mite and commonly called 'scab', has caused great losses to flockmasters of the Old World for thousands of years, being mentioned by Latin writers about 150 B.C.; but it is now officially recognised by the Ministry of Agriculture that one dipping in a 0.1% suspension dip of BHC is adequate for complete control of this ancient scourge.

In South Africa where the dipping of cattle in arsenical dips has been the normal routine for many years, strains of ticks which are arsenic-resistant have gradually evolved, but these have been shown to succumb rapidly when arsenic is replaced by BHC in the dipping fluid.

Another interesting line of approach to the utilisation of BHC is that of oral administration. It has been found that the blood of rabbits and of cattle dosed with the chemical remains toxic to several blood-sucking arthropods (including ticks and tsetse flies) for at least 14 days. This method seems to have great potentialities.

Limitations and Dangers

The outstanding advantage of these modern insecticides over those formerly in commercial use is their high toxicity, prolonged residual action, constant composition and cheapness. These characteristics make it feasible to deal with many pests against which the available measures were too expensive or the chemical was insufficiently potent, e.g. soil-dwelling pests of cereals and other grasses. Further, unlike arsenic, nicotine, and hydrocyanic acid, they are of very low toxicity to man and warm-blooded animals. Despite their unique properties, both DDT and BHC have their limitations and dangers. Neither compound gives the spectacular knock-down of pyrethrum; and, like derris, both are deadly to fish. A limiting factor in the use of crude BHC is its tendency to impart a chemical taint to certain crops, notably potatoes, peas, onions, carrots and raspberries. In addition, sprays containing 0.1% of BHC are liable to scorch cabbage seedlings, for instance. So far as is known, DDT adversely affects only a few plants, most of them belonging to the cucumber family (*Cucurbitaceae*). Owing to the persistent nature of the deposit of insecticide left on the plant after spraying, the usual cleaning processes to which fruit and vegetables are subjected may fail to remove significant fractions of the deposits, with consequent danger to health; for although there is a wide margin of safety in the reasonable use of DDT it can induce toxic features in animals and man. Vegetables should certainly not be treated within two weeks of harvesting. Cereal grains have a protective sheath, so there is little risk of contamination in this instance, but the treatment of forage crops involves a more serious hazard. Thus, American pharmacologists have found that when cows are fed on crops treated with DDT, the chemical tends to accumulate in the butter-fat fraction of the milk, to the amount of 530 parts per million. Close watch is being kept on this lest there might be any danger to babies, since DDT is a cumulative poison, although harmless in small amounts.

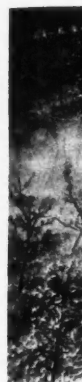


FIG. 1. The effect of DDT on the life cycle of the housefly.

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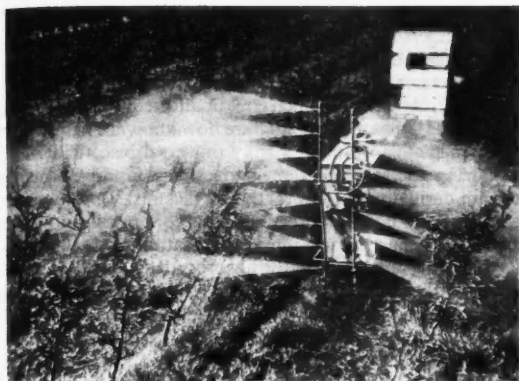


FIG. 2 (Above).—A 200-gallon 'Hatley' spraying machine spraying for red spider control.

(Photo: A. C. K. Ware Ltd.)

FIG. 3 (Right).—A special high-clearance tractor designed for garden plantations in England and for coffee plantations overseas.

(Photo: Bruce, Cambridge)



Effects on the Balance of Nature

An unfortunate feature of these potent and persistent modern insecticides is that they do not differentiate between friend and foe in the world of insects. In general, there are three groups of insects which are beneficial in their activities:

- (i) *Pollinators*, e.g. bees and a miscellaneous assemblage of beetles;
- (ii) *Parasites*, e.g. flies and wasps whose larvae devour other insects from within;
- (iii) *Predators*, e.g. beetles and lacewings which capture and devour other insects.

Although spray-deposits of DDT are relatively innocuous to bees, the dusts are more dangerous; whilst open blossom sprayed with BHC is *extremely toxic to bees*, and involves serious danger to the brood through contact with contaminated food brought home by the workers before they eventually succumb. This chemical is also lethal to both the larvae and adults of hover flies and ladybird beetles, as well as to numerous beneficial parasites of noxious insects. To protect the pollinating insects, therefore, it is essential to avoid spraying open blossom, and many countries enforce this by legislation. Attempts have been made, so far without success, to discover a strong deterrent which would repel bees and could be incorporated in the spray from the spraying material. (Bees tend to avoid crops sprayed with arsenic in combination with lime-sulphur or volatile substances such as nicotine, and certain spreaders).

Red spider, mealybugs and many species of 'greenfly' are practically unaffected by DDT, and actually tend to increase where it is used alone. There is little doubt that this is due to the lethal effect of DDT on the natural enemies of these pests, e.g. it may kill about 30 different insect-enemies of red spider. Also, if this insecticide be used soon after the fruit buds of orchard trees and bushes have burst, it may eliminate some 20 species of beetles which act as pollinators in almost any kind of weather.

In Canada, Burma, and the United States, where vast stretches of country have been dusted with DDT from aeroplanes, there are indications of serious disturbance in the natural balance of wild life. Judging from the mortality caused by DDT applied from aircraft to control forest insects in America, it is advisable to use not more than 0.2 lb. per acre in oily solution to avoid harm to fish, and not more than 2 lb. per acre to avoid harm to birds and mammals. It should be applied before the leaves appear in the forests and again after the nesting season; and never directly to streams and lakes, because of the susceptibility of aquatic predatory insects, crustaceans and fish.

There is no doubt, therefore, that because of the greater susceptibility of numerous parasites and predators than the pests themselves, and the rapid resurgence of pests in the virtual absence of natural enemies, the *indiscriminate* use of these new chemicals might seriously upset the balance of nature.

Enhancement and Selectivity

An American firm has recently marketed a polyethylene polysulphide, which, when sprayed on foliage, forms a transparent, adhesive, weather-resistant film. Preliminary experiments have shown that when this substance is employed in the rôle of a 'sticker' it enhances the effectiveness of DDT sprays. It is suggested also that a reduction of at least 50% in the arsenical dosage is possible if this compound be incorporated in sprays of lead arsenate. Attempts are being made to render DDT partly selective in its action, with the object of countering the disadvantage of its use in relation to beneficial insects. Some success has been claimed and further results are awaited with interest.



(By courtesy of Pest Control Ltd.)

FIG. 4.—A 4-ft. high-clearance tractor working on a mustard crop.

Outbreaks of red spider, following the use of DDT on fruit trees, can be checked by employing a combined spray (or dust) of DDT plus an acaricide (mite-killing preparation), such as dicyclohexylamine-2,4-dinitro-6-cyclohexylphenate. As already stated, one of the disadvantages of DDT is its low knockdown value, but there are now available certain preparations of 'activated' DDT based on an emulsion carrier which increases the permeability of insect-cuticle, and thereby accelerates the toxic action of the insecticide.

Other Synthetic Insecticides

The advances of DDT on the older insecticides, and the veiled secrecy around it during the war, were conducive to a flood of publicity for this particular product, but no longer does it stand alone in the limelight; and with the advent of still more efficient pesticides, both DDT and BHC may occupy minor rôles sooner than seemed probable a few years ago. An excellent insecticide, $C_{10}H_6Cl_4$, was first synthesised in the laboratories of the Velsicol Corporation, Chicago. It is a viscous, colourless, odourless liquid, soluble in most organic solvents but insoluble in water. This product has remarkable insecticidal properties, being intermediate in toxicity and persistency between DDT and BHC. Compared with DDT on an equivalent weight basis, '1068' is of the same order of toxicity to warm-blooded animals, but lower percentages are required to obtain effective results against insects. Particularly susceptible to '1068' are the following: cockroaches, grasshoppers, bed bugs, mosquitoes, byre flies, house flies, Pharaoh's ant, grain beetles and Colorado beetle.

Tetraphosphoric acid has been a laboratory curiosity for a long time, but during the recent war Bonrath of I.G. Farbenindustrie found that *hexaethyl tetraphosphate* was highly toxic to aphides. Because of the shortage of nicotine in Germany at that time, this discovery was applied to horticulture, with excellent results. HETP ($C_{12}H_{30}O_{13}P_4$) is a brownish liquid, soluble or miscible with water and most organic solvents. In contact with water, it decomposes within 24 hours into phosphoric acid and alcohol. There is thus no danger of any harmful residues remaining on fruit or vegetables. Another advantage is that it is not

toxic to plants, while the recommended concentration of 0.06% offers no danger to domesticated animals. This insecticide is both cheaper and more effective than nicotine against 'greenfly' and thrips. Since it is particularly effective against many insects which are unaffected by DDT, and substances lethal to red spider are now known, attempts are being made to formulate a truly universal insecticide.

During the aforementioned investigations in Germany, certain derivatives of fluoroethanol (acetals) were found to act as potent contact insecticides, in concentration as low as 0.1%. A particularly interesting feature of these acetals is that they are apparently absorbed by the leaves and roots of the plant, which is thereby protected for several weeks against all kinds of plant-feeding insects. Unfortunately, these 'internal' insecticides are also highly toxic to warm-blooded animals, but they are at least suggestive of interesting possibilities in the realms of plant-protection. For example, they have obvious advantages against leaf-miners, stem-borers, root-sucking aphides and other insects which are difficult to control because of their inaccessibility. Compounds such as bis (dimethylamino) phosphoryl fluoride, with a similar 'internal' action, resemble the fluorophosphonates studied at Cambridge (see DISCOVERY, 1947, p. 311). Another German discovery, diethyl-nitrophenyl-thiophosphate, is now being manufactured in this country.

In the United States, protection of plants against insects and eelworms has been achieved by using sodium selenate, but this compound is a dangerous poison to higher animals.

Recently it has been shown that a .2% spray of bis (bisdimethylaminophosphorous) anhydride is 'internal' or systemic in action, is particularly effective against aphides, and is selective in being relatively non-toxic to beneficial insects. The systemic action is negligible, however, in plants which have stopped growing, and some plants are intolerant. Nevertheless, this new insecticide has a remarkable combination of desirable features; being systemic, selective, persistent, and non-toxic to mammals when it is used in appropriate dilutions. The outstanding characteristics of an insecticide such as the above is that the natural enemies of the pest are enabled to supplement the artificial control of the chemical; and, incidentally, this also decreases the risk of development of *resistant strains* of the pest.

Orchard Sprays

The serious hazards formerly associated with commercial fruit growing, due to pests and insect-borne diseases, have been greatly reduced by the improved winter-washes—originally introduced from Holland in 1921. Excellent though they are against overwintering eggs of aphides on apple, plum, pear and currants, they are of little use against the eggs of capsid bugs, which require a petroleum-oil wash of 7.5% strength. This double spraying may now be avoided by using a dinitro-ortho-cresol (DNOC)—petroleum wash. With these new washes, 90% of the DNOC remains in solution in the oil, thereby ensuring enhanced ovicidal efficiency. Further, by destroying scale insects, and the eggs of aphides, capsids, winter moths and red spiders, simultaneously, the separate functions of tar-oil and petroleum washes are secured at one

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operation. Essential precautions are to avoid contamination with other sprays, to use only on dormant trees, and to arrest spraying in frosty weather. Certain thiocyanate washes have achieved popularity of late since they are more convenient to use than DNOC, are harmless to warm-blooded animals, and are particularly effective against red spider and woolly aphis—two pests which have hitherto been difficult to combat by any known method.

Insecticidal Smokes

Application of pyrethrum in the form of a smoke was practised by the Chinese for centuries. Since the war, developments have taken place in this method of insecticide application, for controlling pests of warehouses and glasshouses. Fundamentally, the method consists of mixing the insecticide with a pyrotechnic powder which burns slowly, with a low ignition temperature. Smoke generators containing DDT, BHC, and azobenzene, as toxic agents, are now in commercial use. The azobenzene 'smokes' are intended primarily for control of red spider, and the others for controlling a variety of insect pests. All that is required is to apply a flame to the generator, lock up the glasshouse for 12 hours—and then repeat the operation after 10 days to give control of red spider.

Control of Roundworms

The nematodes (roundworms) that parasitise plants present an increasingly serious problem in Britain, especially in the districts where potatoes have been grown, year after year, for a long time. In some districts, the total yield of potatoes is little more than the weight of seed-tubers planted. Encouraging results were obtained before the war in an attempt to control potato-eelworm (*Heterodera rostochiensis*) with phenyl isothiocyanate (found in the roots of various *Cruciferae*); a discovery which explained the known adverse effect of white mustard plants on cyst-formation in infected soil. Recent results indicate that allyl isothiocyanate, which is cheaper, may also be more effective in controlling this pest.

Experiments conducted in the English Fens, using calcium chloroacetate at the rate of 3 cwt. per acre, produced a significant increase in the yield of sugar-beet, in fields heavily infested with beet eelworm (*H. schachtii*).

Recent tests made in several countries, with the object of discovering an effective control for eelworms in glass-houses, have shown that, of several soil-fumigants, chloropicrin and D-D (a mixture of 1,2-dichloropropane and 1,2-dichloropropylene) are the most promising. Both give good control but do not eradicate root-eelworm of tomatoes (*H. marioni*), when the soil contains undecayed infested rootlets. Chloropicrin produces a marked response in plant-vigour, and may indirectly influence soil-fertility. In addition, D-D is lethal to wireworms, cutworms and several other soil-pests, but the cost of treatment is high. If the chemical stimulant to larval emergence from the cysts (present in the root-secrections of attacked plants) could be identified and manufactured on a commercial scale, the potato eelworm problem might be solved, and developments in this field of research are expected.

Parasitic worms are almost universally distributed in animals, domesticated and wild, but it is the sheep-industry

which suffers the greatest loss from this insidious menace. All that is implied in the term 'good husbandry' is still of fundamental importance in the maintenance of clean, thriving stock, but phenothiazine, has revolutionised the treatment of animals suffering from gastro-enteritis due to parasitic worms. This drug has been known to chemists as thiodiphenylamine since 1885. Not until 1934, however, was it utilised for any biological purpose, when American workers proved its lethal action upon mosquito-larvae. In 1938, it was found to be effective against certain worms in swine, especially the large roundworm.

During recent years, millions of sheep, thousands of other farm stock—and several hundred human beings—have been dosed with the drug, the conclusion being that despite its vermifugal properties, phenothiazine is poisonous in certain circumstances. Care is, therefore, required in dosing very young animals, particularly calves, piglets and children. Phenothiazine, however, is of no value in the treatment of whipworms, tapeworms, or flukes. Dosing with capsules of carbon tetrachloride has materially reduced the number of deaths and abortions which formerly resulted from heavy fluke-infestation in sheep. On account of their susceptibility to carbon tetrachloride poisoning, the dosing of cattle for fluke-infestation is risky, but promising results are being obtained with hexachloroethane, which can be administered safely in large quantities.

This article will give an impression of the extent and diversity of the pest problems now engaging the attentions of entomologists, parasitologists and biochemists, in their attempts to discover better and cheaper pesticides. Although there is still ample scope for developments, the brilliant discoveries of recent years have placed powerful weapons at the disposal of those engaged in the struggle against insect and other pests. To the enterprising industrialists, we are indebted for making possible the practical applications of these discoveries on a global scale.

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DISCOVER

A black and white photograph of a large, multi-story brick building. The building has a classical architectural style with arched windows and entrances. The text "LIVERPOOL SCHOOL OF" is visible on the left side of the building, and "TROPICAL MEDICINE" is visible on the right side. The building is situated on a street with a sidewalk and a road in front of it.

The school was founded before the similar body in London, and is, in fact, the oldest in the world. Its jubilee is thus an important event in world medicine. It is one of the few institutes in Europe given over to the study of tropical disease, and represents a vital link between the study of disease in the field and the basic general medical research, for which it is famous. It will doubtless play an important part in the development of the scientific outlook of the new colonial universities, and in the training of their future personnel. Sir Joseph Chamberlain, when he initiated in 1898 the political movement which eventually

In many respects the problems of medicine in the tropics differ from those in this country; in the former, for instance, the main cause of ill health is community-wide disease, often dependent for its spread on insects or other vectors and associated with malnutrition. Disease on this community scale can be dealt with only by preventive measures. In recent years it has been realised that in the tropics medical facilities have been available for the most part only to people in towns and large villages, and have not been readily available to rural areas, whose inhabitants form by far the largest part of tropical populations. The amalgamation of the Diploma Course in Tropical Medicine

New trends of the staff of entomology towards the days most tested was carried out now both to an ever-increasing sites and the transmit these. In short, the to provide for aspect in the live strains of been established and the house necessitated insectaries and conditions of test

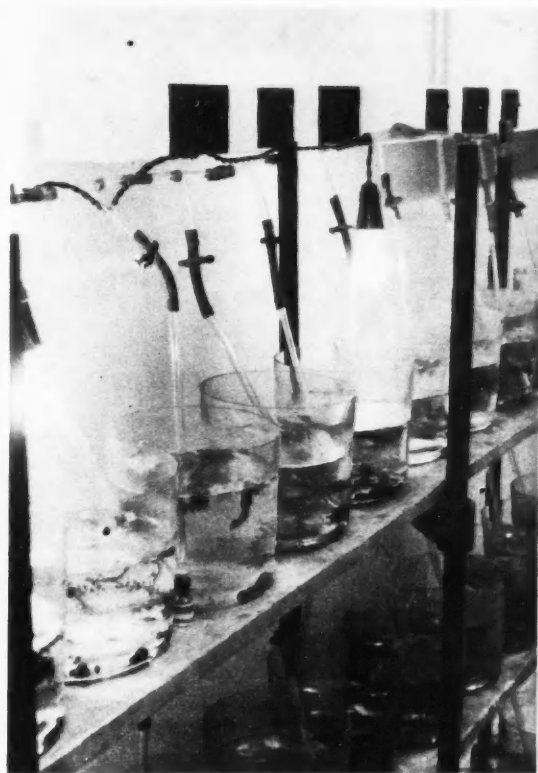


FIG. 2 (left).—Breeding anopheline mosquitoes, the carriers of malaria. (Right) Breeding snails for work on schistosomiasis. This is part of the work going on in the new aquaria and insectaries which are amongst the finest in the world.

and Hygiene is an indication of the school's insistence that preventive medicine holds out the best hope for the tropics, and that individuals trained to work in the tropics should be instructed in the means of developing medical facilities in rural areas. At the same time an attempt is made to stimulate the student's interest in the basic problems of tropical medicine with the object of demonstrating some of the outstanding problems that require research.

New trends in teaching may also be seen in the approach of the staff of the Department of Entomology and Parasitology towards the teaching of these subjects. In the old days most teaching and a considerable amount of research was carried out with preserved material from abroad, but now both teaching and research tend to be directed on an ever-increasing scale towards the study of living parasites and the various insects and other creatures which transmit these organisms to man and his domestic stock. In short, the museum is giving place to the zoo. In order to provide for the teaching of parasitology in its applied aspect in the field and to study material for research, many live strains of insects, worms, molluscs and protozoa have been established. This work entails much care and labour, and the housing and maintenance of these creatures has necessitated the installation of specially equipped rooms, insectaries and aquaria, in which the natural tropical conditions of temperature and humidity can be accurately

imitated. Some of these rooms have had to be duplicated in separate buildings, for so efficient are modern insecticides that it is impossible to experiment with them in buildings in which the insect strain is housed. The preserved and living material from the tropics is received from many sources, but a steadily increasing number of specimens is being collected by members of the school's staff during their numerous expeditions to the tropics.

Transmission and Control of Malaria

In its fifty years' history the scientific research work of the school has continued without a break. It is on the remarkable scientific achievements of its staff that the reputation of the school is mainly based. The school started off well by appointing Ronald Ross as its first malarialogist and lecturer in tropical medicine. Ross, inspired by Manson, had just completed a series of brilliant experiments which culminated in the demonstration that malaria of birds could be transmitted by mosquitoes. Mosquito transmission of human malaria had been rapidly confirmed by Italian research workers, and in the first school expedition sent to Sierra Leone in 1899, Ross demonstrated the presence of infected anopheline mosquitoes in Freetown, and subsequently in the Gold Coast and Nigeria. This work was extended in Africa in the

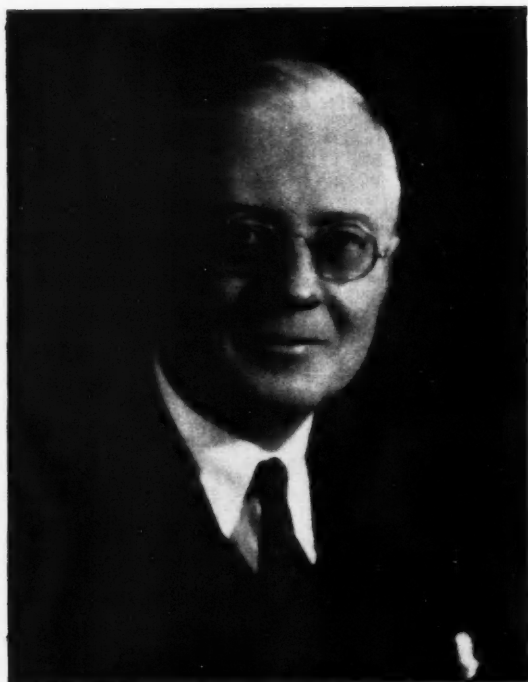


FIG. 3.—Warrington Yorke whose researches in chemotherapy have been of lasting value to tropical medicine.

next few years, particularly with a view to developing methods of mosquito control which have long since become standard. Ross stayed with the school until 1913, when he went to London and was succeeded by Stephens, already a member of the staff, who contributed considerably to the knowledge of malaria, and its chemotherapeutic control. Stephens identified and described the fourth human malarial parasite, *Plasmodium ovale*, in 1922, and played a leading part in the development of the use of malaria in the treatment of neurosyphilis. A great deal of the pioneer work in the study of the bionomics, identification and classification of many African insects, particularly mosquitoes, was brilliantly carried on in parallel with the more practical study of malaria, especially by Newstead, the first Professor of Entomology.

Stephens was eventually succeeded by Warrington Yorke who, in his earlier days with the school, had played an important part in the study of blackwater fever. Warrington Yorke carried out a great deal of detailed work on the control of malaria by quinine during the 1914-18 world war, and subsequently established a world-wide reputation in the study of the chemical control of disease in general. The chemotherapy of malaria has always been one of the preoccupations of the school's staff, and a tremendous volume of work on this subject has been carried out both in Liverpool and in the laboratory in West Africa.

Until after the 1914-18 war quinine was the only known drug which had a specific effect on malaria, but in the interval between the wars, two synthetic compounds were developed by the Germans which were of great importance

in the clinical control of the disease. One of these was the yellow drug mepacrine which those who served with the Forces during the recent war will well remember. At the outbreak of the 1939-45 war the British and Americans were still largely dependent on quinine for the control of malaria. They had not used mepacrine (or atabrine as it is called in America) to any extent. To Yorke, amongst others, the danger of possible Japanese intervention in the war was obvious. If the Japanese succeeded in over-running Java the Allies would lose their source of almost all of the world's quinine. He was, therefore, vitally concerned in a vigorous agitation both in this country and in America to procure the manufacture of mepacrine on a large scale. This was eventually carried out, and by 1942 adequate supplies of the drug were coming in, so that when the Japanese did capture Java mepacrine was available for the control of malaria in Allied troops. As a result of Yorke's enthusiasm and energy collaboration between the school and various commercial organisations was established with the object of studying the action of drugs in tropical disease. A malarial unit was established in the Imperial Chemical Industries Laboratories at Manchester, and shortly after Yorke's death in 1943 a team working on entirely new lines developed a new substance, paludrine, which has since been established as one of the most powerful of all anti-malarial drugs. Paludrine was tested out clinically by members of the school staff in the wards of the Tropical Diseases Centre, and the establishment of its efficiency must be regarded as one of the most important recent contributions in this field.

The original demonstration of the activity of organic arsenicals against trypanosomes was made in 1905 in the school's laboratories by Wolferstan Thomas, who subsequently became Director of the Laboratory at Manaos. This work was largely developed by Ehrlich in Germany, but it led eventually to the remarkable chemotherapeutic researches of Warrington Yorke, which continued until his death. Yorke and his assistants discovered methods of keeping trypanosomes alive in cultures and studying the action of drugs upon them. A great many substances were examined in this way and new compounds were tried experimentally in Liverpool, and some investigated further in the field in Africa. In this way the powerful activity of the diamidino group of compounds was discovered in collaboration with May and Baker, Ltd., some of which have proved of considerable value in the early treatment of trypanosomiasis (sleeping sickness) and resistant cases of kala azar. The development of these compounds was an achievement of lasting value to tropical medicine. In his Royal Society obituary notice of Yorke, Wenyon said: "He had the satisfaction of knowing before he died that he had been instrumental in introducing for the treatment of two of the most intractable tropical diseases remedies which will . . . lead to the saving of many human lives." This work initiated by Yorke has been carried on, since his death, in the department of chemotherapy which was established as a memorial to him.

Some of the earlier expeditions sent to the tropics by the school resulted in observations of the highest scientific importance. For instance, during the sixth expedition, dispatched to the Gambia in the autumn of 1900, Dutton observed in the blood of a patient the trypanosome, *Trypanosoma gambiense*, which subsequently became

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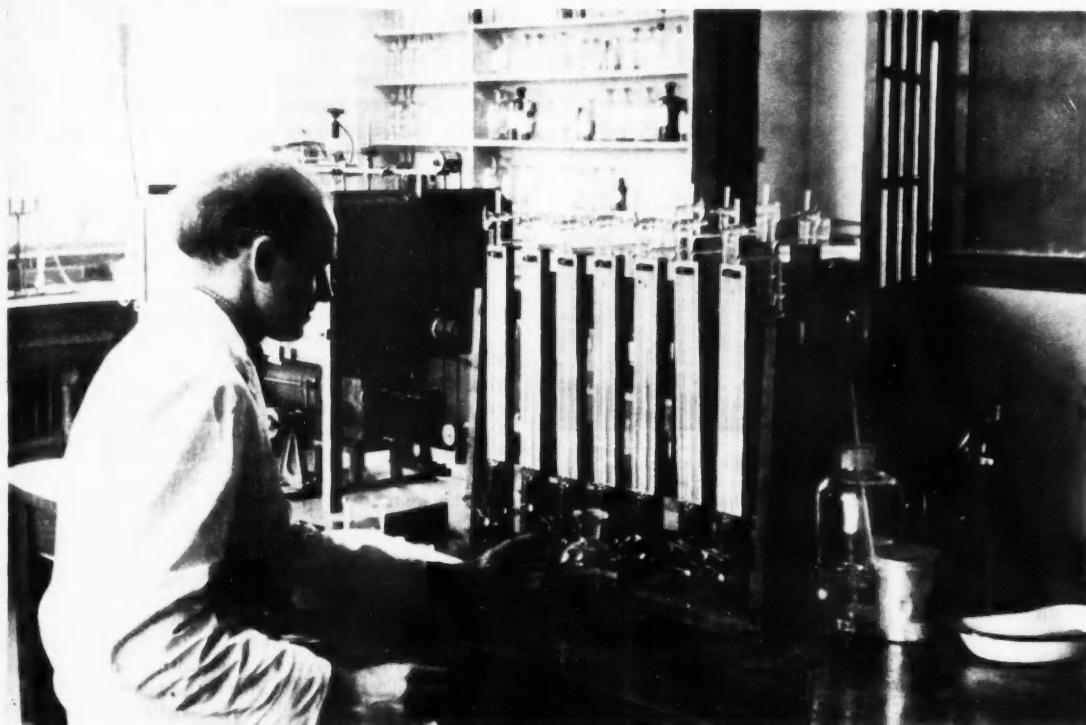


FIG. 4.—Basic research in the Department of Tropical Medicine. Measurement of the activity of respiratory pigments in disease, including malaria.

recognised as the cause of African sleeping sickness. This organism was later brought back to England and established in laboratory animals. Trypanosomiasis subsequently became one of the school's major interests and, in addition to the chemotherapeutic work already mentioned, the transmission of the disease by various species of tsetse flies was described in a classic work by Newstead. It is not too much to say that these simple beginnings are the basis of all the elaborate modern work on the control and treatment of sleeping sickness. Some two years later Dutton, serving with the school's expedition to the Congo Free State, died from relapsing fever shortly after he and his colleague Todd had demonstrated the causal spirochaete in man, a discovery which had been anticipated a few weeks earlier by Ross and Milne in Uganda. Dutton also identified the tick as a local vector and studied its distribution and life habits.

The staff of the school have been actively concerned for many years in the study of yellow fever and the methods of its control. This work was at first mainly concentrated in Manaos in Brazil and resulted in the establishment of the Yellow Fever Bureau which served as a distributing centre for information on the disease and closed in 1915. In between the world wars the staff of the Freetown Laboratory undertook surveys for the mapping out of the endemic areas of yellow fever, and were frequently called upon to investigate outbreaks of the disease. In the first two years of the recent war they controlled the distribution of yellow

fever vaccine on the west coast of Africa, a work subsequently taken over by the re-established Rockefeller Laboratories in Lagos.

Laboratory in Sierra Leone

Up to the 1914-18 war the school's work abroad mainly depended upon the enthusiasm of the business-men of Liverpool, who provided financial support for various expeditions to Africa and elsewhere; but in 1921, with the foundation in Freetown, Sierra Leone, of the Sir Alfred Jones Laboratory, a new phase in the history of the school began. The laboratory was placed under a director who was also a member of the Liverpool school's staff and held the University Chair of Diseases in Africa, and thereafter until the early stages of the 1939-45 war the field work of the school was mainly concentrated on the west coast of Africa. Important as it was, the research work of this institute was by no means its only function. The influence of the laboratory as a training ground for post-graduate workers in tropical medicine has long been world-wide. During the war it acted as the main pathological and scientific centre for the Colony and Protectorate of Sierra Leone, and trained large numbers of medical officers for the Forces. The work of the laboratory until its temporary closure in February 1941 was continuous and extremely productive. Research on malaria and trypanosomiasis has already to some extent been mentioned.



FIG. 5.—Investigation of liver failure in malaria and study of intrahepatic circulation being carried out in the Department of Tropical Medicine.

It would be impossible to recount the rest of the work here, but reference should be made amongst other work of the first demonstration of the life-cycle in the simulum fly of the filaria worm *Onchocerca volvulus*, a frequent cause of blindness in Africa and Mexico; the important survey of bilharziasis in Sierra Leone; the first report of endemic typhus in the Colony and the careful and tedious work carried out in the field of rural hygiene. The study of the control and transmission of malaria and other endemic diseases constituted the major work of the staff of the Freetown Laboratory and inevitably led them to stress the basic importance of hygiene in rural as distinct from urban communities, a point of view which is strongly emphasised today in the school's teaching. It is now seven years since this laboratory was closed following the illness of its Director, now Professor of Tropical Hygiene, and it is to be hoped that in the near future it may soon function again as a centre of medical importance.

Emphasis was laid on clinical practice during both world wars. In 1915 the school buildings were used as a military hospital, and in the second world war the school developed and ran the largest and most active centre for the clinical care of patients from the tropics that has ever existed in this country. This centre is still functioning on a small scale in one of Liverpool's regional hospitals and is now a permanent feature of the school's work. During the war the patients were mostly service-men, but today many of them are merchant seamen who have served in tropical ports all over the world.

The experience gained by members of the school's staff in West Africa was of considerable value during the recent war. In 1940, for instance, a former director of the Freetown Laboratory visited Sierra Leone at the request of the Secretary of State for the Colonies, and was instrumental, in collaboration with the local authorities, in greatly reducing the incidence of malaria in naval and merchant shipping in the harbour of Freetown, then vitally important as a great convoy centre for all shipping to and from Africa and the East. This work was later extended to other harbours in the British West African Colonies.

Chemotherapy

The developments in chemotherapy sponsored by Yorke were also of importance in the war. The Sudan Government, for instance, acknowledged the value of diamidine drugs in the control of kala azar, which in the summer of 1940 was threatening with disaster the Allied armies on the Abyssinian and Eritrean borders. The development of paludrine has been mentioned above. Other important work included the clinical evaluation of a new drug for the treatment of scabies, tetmosol, synthesised by Imperial Chemical Industries Limited.

In recent years the school's interest in chemotherapy has been maintained, especially with regard to the clinical activity and pharmacology of mepacrine, paludrine and its analogues, and modern drugs for the treatment of leprosy and amoebic dysentery. The basic interest in malaria and blackwater fever is as live as ever, but in the Department of Tropical Medicine the emphasis has been changed and now lies on the physiological effects of these diseases in the body. This fundamental approach to the problems of malaria has proved to be of considerable importance to medicine in general since it has been discovered that many of the pathological and physiological effects of malaria and blackwater fever are paralleled in other diseases, many of which are non-tropical. This is particularly true of damage to function and structure observed in the kidneys and liver, the pathological processes underlying which are being studied. The significance of this work has recently been acknowledged in a generous manner by the Liverpool firm of John Holt and Company (Liverpool) Limited by an unfettered grant of £10,000 to the Department of Tropical Medicine. This gift is a further example of the interest and goodwill towards the School shown by local merchants trading in tropical countries, and will enable the department to develop the fundamental approach to the problems of malaria in a way which would have been quite impossible otherwise. It stresses, too, the enormous importance of fundamental work, which can be carried on unhindered in relatively few places, and it may be regarded as gratifying that such work should be singled out for encouragement from amongst the more spectacular and immediately profitable distractions of practical medicine, which could be carried on with equal or greater facility elsewhere.

Various problems of injury and disease caused by parasites and household creatures affecting not only man but also his domestic stock, both at home and abroad, are being investigated in the Department of Entomology and Parasitology. Some of the problems which affect residence in the tropics can be fully investigated in this country. For example, the effects of insect bites and the stings of various obnoxious and venomous creatures are being studied in Liverpool with live specimens brought from abroad. Similarly, the action of various insecticides on parasites such as cattle-lice and the warble-fly (pests of the farmer both in this country and abroad) is being studied in the special insectaries already referred to. On the other hand, investigation of certain worm infections, such as schistosomiasis and filariasis, which cause widespread disease amongst the human population in the tropics, can be satisfactorily carried on only by combining laboratory investigations at home with field observations abroad. As a result

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of such liaison, our knowledge of filariasis has recently been increased considerably. In the laboratory a similar but not identical filarial worm has been maintained in animals and transmitted to previously uninfected hosts by the appropriate insect vector. At the same time members of the staff working in Africa collect, study and bring back to the school the parasites and vectors responsible for the disease in Africa. In this way as a result of work begun in Liverpool a newly introduced drug has been found to protect animals from filarial infection, and it is hoped that on their next visit to Africa members of the staff may have an opportunity of testing its value as a prophylactic against human filariasis.

The work of the school staff covers much more than has been mentioned. A complete catalogue of their scientific activities is out of the question here, but a word may be said of the close liaison between the staff and other institutions responsible for medical research. A good deal

of the work is supported by the Medical Research Council and the Colonial Office, and trainees for the new Colonial Medical Research Service have already been admitted to the laboratories. The staff also play an active part in colonial welfare and development schemes, and sit on many of the committees which direct them, including the Colonial Advisory Medical Committee and the Inter-University Council for Higher Education in the Colonies. Recently the school has earned a unique distinction by supplying a second consultant for the new Panel of Consultants set up by the Secretary of State to the Colonies jointly with the Nuffield Foundation. The objects of this panel are to provide a stimulus for the Colonial medical staff and some kind of continuous liaison between professional personnel in this country and those trained in the new Colonial medical schools, and to keep members of medical staffs in the United Kingdom informed regarding work and opportunities in Colonial medicine.

PIONEER OF HYDROGENATION—continued from p. 211

Not that he was wholly disinterested in this aspect of his work: he took out several patents and he was also consultant to industrial concerns. But these activities were in the nature of side-lines; his real interest lay overwhelmingly in pure science. Indeed, it was an Englishman, Crossley of Warrington, who, in 1903, first drew his attention to the practical implications of his discovery for the hardening of oils.

Crossley inquired whether the nickel catalyst would be suitable for the hydrogenation of olein into stearin, i.e. the conversion of liquid oils into solid fats. To this question Sabatier was able to reply in the affirmative solely on the strength of his conviction about the mechanism of catalysis. Holding firmly to the chemical theory of catalysis, he saw the mechanism of hydrogenation in the formation of a definite hydride of nickel, which dissociates and yields up its hydrogen readily to substances capable of absorbing it, thus regenerating the nickel which combines with more hydrogen and starts the process all over again. This hypothesis was later confirmed by other researchers who succeeded in preparing a hydride, NiH_2 , which possesses remarkable abilities as a direct hydrogenising agent. Nothing in the chemical theory seemed incompatible with catalytic hydrogenation of liquids, as the finely divided nickel immersed in the liquid could easily be brought into contact with hydrogen to form the hydride. Sabatier therefore concluded that the conversion was feasible. (Incidentally, catalytic hydrogenation in the liquid phase is incompatible with the physical theory which attributes catalytic power to a physical condensation of the gas with the pores of the catalyst.)

This was the beginning of the great industry of the hardening of oils—but Sabatier never derived any material profit from an invention which was a direct consequence of his discovery.

His prestige, however, was growing. In 1901 he was elected a corresponding member of the Academy of Sciences, and in 1905 he became Dean of the Faculty of Sciences of the Toulouse University, a position he was to hold for twenty-five years. His fame spread rapidly, and

in 1907, on the death of Moissan, he was offered the chair of chemistry at the Sorbonne. This he refused, however, and shortly afterwards declined an even more tempting offer, that of the chair, left vacant by the death of Berthelot, at the *Collège de France*. A year earlier he had created at the University of Toulouse the Institute of Engineering Chemistry for the training of chemical engineers, and not even the temptation of becoming Berthelot's official heir could lure him away from his beloved university.

This refusal, however, meant that he could not become a full member of the Academy of Sciences, as the rule then prevalent restricted membership to residents of the capital. But the rule was amended in 1913, after Sabatier (together with Victor Grignard) had been awarded the Nobel prize in 1912. The Academy decided to add to its company of sixty, six non-resident members, and Sabatier was the first of these to be elected. In the same year he published his magnum opus, *La Catalyse en Chimie Organique*.*

More honours rained upon him. In 1915 he was awarded the Davy Medal of the Royal Society, and three years later became a Foreign Member of the Royal Society. He was also made a Foreign Member of the Academies of Amsterdam, Washington, Rome, Stockholm and Madrid.

As far as research work was concerned, his active life came to an end in the mid-twenties and from then on he devoted himself entirely to his Institute of Chemistry to which his fame had drawn students from all parts of the world. In 1930, at the age of seventy-five, he retired from his posts as Dean of the Faculty and Director of the Institute of Chemistry, but continued to lecture almost until the end of his life.

He died at Toulouse on August 14, 1941, at the age of eighty-seven. His death broke one of the last remaining links with the great Berthelot. His life had been a fitting illustration of how scientific research pursued for its own intrinsic interest can lead, and often does lead, to important advances in the material welfare of mankind.

* English translation from the 2nd French edition (1920) by E. Emmet Reid, *Catalysis in Organic Chemistry*, New York, 1922.



Chalk Houses

REGINALD M. LESTER, F.A.L.P.A.

EXPERIMENTAL chalk houses, which are now being built near Andover, Hampshire, have focused attention upon this material as a medium of construction that offers a method of building requiring none of the materials involving the use of coal in their manufacture.

It was shortly after the end of the first world war that initial investigations were made into the possibilities of building a house with crushed chalk. Although there was widespread prejudice for many years against chalk as a good building material, its claims for such purpose are very strong indeed.

In several parts of the south of England are innumerable houses, and even churches, built of chalk—one or two of the latter being a thousand years old, and still in an excellent state of preservation.

The very first experimental chalk building was in 1919, but at that time was carried out by people entirely without experience of that type of material. The first pair of cottages upon a hillside was built in 1923, using the site material, which is especially appropriate to hillside building owing to the saving of haulage. These cottages were lived in for ten years until they were accidentally burnt down, but they confirmed the claim that chalk was ideal as a

building material. It proved that the hygienic properties were excellent, and, once dry, the house would not only remain dry, but would absorb a considerable amount of the moisture that is generated in ordinary traditional houses by our normal winter conditions.

These cottages were built by manual labour, and the chalk taken out of the hillside was rammed by hand. Timber planks, supported by vertical uprights, were used for the shuttering, and these were laid continuously, plank upon plank, as course succeeded course. The 18-inch-thick walls were built upon a brick foundation 1 ft. high. The whole work was carried out by unskilled labour, but was supervised by a man who knew the snags to avoid if such building was to be carried through successfully. Furthermore, these early experimental houses showed what improvements could be effected in future buildings.

Many of the earliest chalk houses were built at the time when damp courses were unknown, and the protection of chalk walls against heavy rain during construction was a difficult task. Nowadays, of course, mechanical pulverisers can make a much better job of crushing the chalk than was the case when it had to be done by hand. It has been found that crushed chalk is very much more

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satisfactory for all forms of chalk building than the rock and powder taken straight from the cliff face.

In spite of these satisfactory experiments, however, chalk building again fell into disrepute when some houses were built under a Government scheme. Orders had merely been given to build chalk houses, but those in charge of the job were entirely inexperienced. The wrong methods were used, costs were high, and the results unsatisfactory. Quite naturally, the Government report, subsequently published, was decidedly adverse.

The next experiments were launched in 1932, when a building team was organised possessing a higher degree of knowledge and experience than in the previous cases, and also using the services of an architect. These proved remarkably successful, and a house of 24,380 cu. ft. was built. A mechanical pulveriser—a 'Miller' pan mixer, into which was poured chalk and water—gave the resulting 'pug', which produced just the effect required. This pug was poured into moulds, where it set without ramming. After twenty-four hours the block could be moved and built into the walls. Moist chalk, mixed with a little sand, was used to bond these blocks together. Careful costings were taken and the price of the house was found to be approximately £850, or about 8½d. per cu. ft., as compared with normal costs of 1s. or over. Incidentally, this property was resold in 1944 for £2000.

Both partition walls and main walls of the house were of chalk; there were no brick chimney-stacks; and a length of asbestos flue was fixed immediately above the hearth, the smoke passing to the open air through an aperture in the chalk.

These satisfactory results promoted the building of a further pair of cottages specially for agricultural tenants. In this case, the walls were 1 ft. thick, there was a thatched roof, and the cost worked out at about £550 the pair.

Subsequent experiments were continued. It soon became clear that chalk could be crushed dry as well as wet, and that chalk walls—preferably 2 ft. thick—could easily be recessed from within, so that furniture and cupboard accommodation could be built into them. A satisfactory composition flooring with a chalk base was found possible, and it was also found that this material could be used for the construction of sliding doors and windows.

All these discoveries were about to be incorporated into further experimental building when the second world war broke out, and it was not until this year that another advance has been made.

One rural council, which is planning to erect fifty chalk houses, is convinced that, with the shortage of houses today, here is a material which can be quarried locally, whereby good houses can be built well and cheaply through the medium of unskilled labour, but that although such labour can actually be used on the job, it must be under the supervision of someone who has knowledge of the correct methods.

It has been found safe to build a wall exposed to the weather as thin as 10 inches, whilst interior walls can be as thin as 6 in. or even 4½ in.

Horizontal surfaces must be protected until the roof is on, otherwise there is always a danger that the chalk will reach saturation point during protracted periods of bad weather. Chalk is somewhat like blotting paper, in so much as it is absorbent and will not let the weather penetrate inside, while at the same time it will absorb any interior moisture. It is also fire-resistant.

It is proposed that future chalk houses will have flat rather than sloping roofs, and plastic products are likely to play a part in both doors and windows.

It must be realised, however, that chalk building calls for the combined talents of builder, engineer, and chemist if any further failures are to be avoided.



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Science in the Birthday Honours

THE Order of Merit was conferred on two well-known scientists in the Birthday Honours List—Earl Russell, F.R.S., and Sir Robert Robinson, president of the Royal Society.

Dr. David Brunt, who is professor of meteorology at the Imperial College of Science and Technology, was knighted. Other scientists so honoured were: Dr. R. G. Hatton, formerly director of the East Malling Agricultural Research Station, and Professor J. A. Scott Watson, who is Chief Scientific Adviser to the Ministry of Agriculture.

Electronic Flash gives Unique Air Photograph.

AN electronic flash tube was used when the refuelling of a B.O.A.C. Liberator aircraft 9000 ft. over the Atlantic was photographed for the first time. The Liberator was flying non-stop from Montreal to Heath Row. It was located at 2 a.m. 300 miles from Shannon Airport by a 'Lancastrian' tanker which was equipped with radar. In the flight engineer's station of the 'Lancastrian' was the photographer, Mr. T. G. Reeves, and using an electronic flash tube he took the photograph while the two aircraft were flying in formation at 200 miles an hour. The aircraft were about 100 ft. apart, and allowing for the wing span the flash had to carry a terrific distance.

This picture could not have been secured except through using an electronic flash tube. In the Mullard LSD3A tube which was used the average power dissipation during the time of discharge is over 500,000 watts, and the peak is about one and a half million watts. The LSD3A was developed for use in portable flash equipments. The object of the design was to produce a tube giving the maximum intensity of light.

A remarkable feature of the photograph is that the aircrews, whose tip speed is 750 miles an hour, are halted in their tracks. This is due to the rapidity of the exposure which took place in 1/500th of a second while the electronic flash illuminated the airliner.

Chemical Engineering Research

FOLLOWING on a suggestion by the Institution of Chemical Engineers, the D.S.I.R. has set up a committee to investigate research in the field of chemical engineering. The constitution of the Committee is as follows:

Mr. H. W. CREMER (Chairman), Past President, Institution of Chemical Engineers; PROFESSOR T. C. R. FOX (Cambridge University), PROFESSOR F. H. GARNER (Birmingham University), MR. H. GRIFFITHS (British Carbo Norit Union), DR. N. P. INGLIS (I.C.I.), MR. H. NEVILLE (British Chemical Plant Manufacturers' Association), PROFESSOR D. M. NEWITT (Imperial College of Science, London), MR. J. A. ORIEL (Shell Marketing and Refining Company), MR. J. DAVIDSON PRATT (Association of British

Chemical Manufacturers), MR. S. ROBSON (Consultant, Zinc Corporation Group).

Government Science will be represented by the following who will attend: the Directors of the National Physical Laboratory, Chemical Research Laboratory, Fuel Research Station, and the Mechanical Engineering Research Organisation; the Principal Director of Scientific Research, Ministry of Supply.

The Secretary of the Committee is Mr. A. W. Morrison of the D.S.I.R.

Radar and Insects

ONE of the earlier discoveries from the use of radar during the war was that echoes were liable to be received from flights of birds, and it was understood that these were on occasion mistaken for aircraft.

Now, using centimetre-wave equipment, A. B. Crawford, of the Bell Telephone Laboratories, New Jersey, has shown that individual echoes can also be recorded from insects—and, incidentally, from bullets.

His experiments, carried out at the Gila Bend, Arizona, station of the U.S. Naval Electronics Laboratory, provide a rather striking illustration of what can be done in the way of fine measurement with contemporary radar.

The aerial system used consisted of a horn and plastic lens, and was suggestive of ordinary searchlight equipment. Separate aeriels were used for transmission and reception, with the result that mutual interaction was reduced to a minimum, and echoes could be received from almost immediately above the equipment. The experiments were carried out at night, with the aeriels directed vertically upwards, and a searchlight used for visual observation.

A preliminary count was made with the searchlight and radar on different sites. This established that the number of radar echoes from the lowest 250 ft. of the atmosphere was comparable with the number of insects seen visually. The searchlight was then moved to the radar site, and simultaneous observations made with four visual observers so arranged as to obtain a fairly complete view of the searchlight beam.

During one evening 20 radar echoes were observed, of which 15 coincided with visual observations of insects. On the other hand, there were 12 'visuals', for which there was no radar counterpart. The latter are explained by the fact that the searchlight beam was considerably wider than that of the radar.

In another experiment, a low-velocity 0.22-in.-calibre rifle bullet was 'seen' on the radar at its maximum vertical range of 3500 ft.

The radar wavelengths were 3.2 and 1.25 centimetres, the duration of the pulses sent out being 0.15 millionths-second. This would give a discrimination in range of about 70 ft.

Metrology Course at Manchester

IN technical education there is a real danger of the neglect of certain advanced

branches of the work which require elaborate or costly equipment and a staff of specialist lecturers.

The centralisation at the Manchester College of Technology of Post-graduate Courses on Engineering Metrology and the related sections of the subject of Machine Tools is, therefore, a noteworthy development.

Science and British Productivity

THE administrative arrangements by which the Government seeks to ensure the fullest application of scientific knowledge to the solution of problems of productivity and economic development are to be reviewed. An officer of the Treasury, Commander R. G. A. Jackson, will work with and report to the Secretary of the Department of Scientific and Industrial Research, Sir Ben Lockspeiser. Commander Jackson was Director-General of Middle East Supply Centre during the war and was later Senior Deputy Director-General of Unrra.

New Coalfield in Midlands

A NEW coalfield has been discovered in South Staffordshire during the course of deep boring by the Geological Survey and Museum. At a minimum estimate this coalfield contains 400 million tons of workable coal and the amount may possibly be several times as great as this estimate. The seams lie at a depth of about 3000 ft.; 30 ft. of coal has so far been discovered, including seams of 8, 6 and 5 ft. Boring is still going on and it is likely that further seams will be found. The boring is at Whittington Heath near Lichfield.

The new coalfield is situated between the Cannock Chase coalfield and the Warwickshire coalfield in both of which the Productive Coal Measures crop out at surface. The preliminary conservative estimate of 400 million tons is equal to an added life of 80 years for the Cannock Chase coalfield at its present rate of production.

Funds to undertake a programme of deep boring were granted to the Geological Survey in 1947 for the purpose of investigating the deep-seated geological structure of Great Britain. It is unlikely that all the bores will give direct economic results of such importance as the Lichfield bore but the information gained from the bores will enable geologists to interpret the structure of the rocks at great depths beneath considerable areas of the country. Knowledge of this kind is of great general importance in the search for underground mineral and water resources.

Mr. T. Eastwood, A.R.C.S., M.I.M.M., Assistant Director of the Geological Survey in charge of mineral deposits of England and Wales, is responsible for the work and he had previously forecast that coal would be discovered in the Lichfield area. Boring has been carried out by the Craelius Company under contract.

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Silk Research

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£50,000 for Peat Research

To promote research into the industrial uses of peat in Scotland the Government has made an initial grant of £50,000. Apart from the economically useful substances that can be extracted from peat, it also has potentialities as an engine fuel. According to a report in *The Times*, the possibility of burning peat in a gas turbine for the generation of electricity is to be investigated, and there is every prospect of being able to adapt the closed-cycle turbine to burn peat instead of oil. An experimental closed-cycle turbine burning peat is being constructed for the North of Scotland Hydro-electric Board.

The Institute of Physics

At the Annual General Meeting of the Institute of Physics held on May 20, 1949, *President*, Dr. F. C. Toy; *Honorary Treasurer*, Mr. E. R. Davies; and *Honorary Secretary*, Dr. B. P. Dudding were re-elected for the year beginning October 1, 1949 and the following were elected to fill vacancies which will occur on that date: *Vice-President*, Dr. S. Whitehead, *Ordinary Members of the Board*; Mr. T. C. Keeley, Dr. H. L. Penman.

The membership of the Institute of Physics shows an increase during 1948 of 187.

Silk Research

One of the great killing diseases of the silkworm is known as flacherie. An epidemic can reduce the yield of cocoons by 50% or more, and the disease is a serious threat to sericulture. An investigation into the cause and possible cure of flacherie has recently begun. The British Cotton Industry Research Association is responsible for the scientific side of the work, and the scheme is financed by the Silk and Rayon Users Association. Experimental work is being carried out at Lullingstone Castle in Kent, where the only British silk farm, owned by Lady Hart Dyke, is situated.

The symptoms of flacherie become apparent towards the later stages of growth; the silkworm becomes inactive, the body blackens and the worm rapidly dies. A successful method of combating the disease would be immensely valuable to all concerned with the silk industry, but the nature of the disease is obscure and may prove to be due to a virus. Part of the research investigation is aimed at discovering if it will yield to modern methods of treatment such as the use of penicillin.

The silk trade in this country recognised the importance of research in its industry and research has been carried on since the early 1920's. With steadily increasing support from the trade, research on silk as a textile and as a protein is being vigorously pursued at the Shirley Institute, Manchester, headquarters of the British Cotton Industry Research Association. Here in a separate department are the Silk Section Laboratories, devoted entirely to the numerous problems connected with silk.

Experience gained from research work before the recent war solved many difficulties that would otherwise have cost

money and even lives. For example, one of the great dangers to which airmen were exposed during the war arose from petrol fires. Usually a pilot slipped off his flying gloves on going into action as they tended to hamper his movements. Blazing petrol spraying into the cockpit from bullet-pierced petrol tanks frequently caused seriously burnt hands. The Silk Section at the Shirley Institute worked on the development of special gloves packed in a specially designed cover, to deal with this emergency. The pilot ripped this cover open and pulled on a fine silk gauntlet filled with one of the sulpha-drugs in powder form, which thus kept his hands in an antiseptic condition until he reached base.

Another war-time research concerned parachute silk. In 1941-42, silk was becoming scarce because of the war in the Far East. By the use of a new test which enabled the quality of a silk fabric to be assessed and its chemical stability forecast, it was possible to release between 300,000 and 400,000 yards of silk fabric for making into parachutes at a particularly critical time.

Appointments

PROFESSOR F. G. YOUNG succeeds PROFESSOR A. C. CHIBNALL in the Sir William Dunn chair of biochemistry at Cambridge University in October. Professor Chibnall has been in charge of this department since 1943. His predecessor was the late Sir Frederick Gowland Hopkins.

Professor Young, who has held the chair of biochemistry at University College since 1945, was elected an F.R.S. this year. His most notable researches have been concerned with the study of the role of the hormones from the anterior lobe of the pituitary gland in carbohydrate metabolism.

MR. A. G. WARD, M.A., F.Inst.P., has been appointed Director of the newly formed British Gelatine and Glue Research Association. Mr. Ward's main interests have been in colloid science, in particular the relation of colloidal structure to mechanical properties. During the war he was engaged on research on the mechanical and physical properties of propellants and plastics, together with studies on nitrocellulose, for the Ministry of Supply.

'Parsnip' Blisters

The plant known as wild parsnip (*Pastinaca Sativa*) is generally looked upon as harmless enough, but it has now been proved to be the cause of a peculiar kind of dermatitis. Because it produces blisters on skin that has been exposed to sunlight this kind of dermatitis is known as phyto-photo-dermatitis.

An R.A.F. doctor, H. E. Bellringer, describes in the *British Medical Journal*—(June 4, 1949), how he proved the connection between the plant and blisters on the legs of airmen. Two different squads, with forty airmen in each, were sent by their physical-training instructors on a twelve-mile race—the first on July 15 and the second on the 16. The first mile or two was across fields and then over an assault course thickly overgrown with

wild parsnip (*Anthriscus sylvestris*) and yarrow; the remainder of the run was along roads where an occasional patch of cow-parsnip was found in an immature stage of growth. The race on both days was held in brilliant sunshine, and the airmen ran in short trousers, many without vests or stockings. On the morning of the 17th an airman who had taken part in the first run reported sick, complaining of intense irritation and weals on the legs the previous evening, some thirty-six hours after exposure. By the morning large blisters had developed. During the next two days 23 more airmen were found to be suffering from the same symptoms with varying degrees of severity.

Patch tests were then carried out on two hospital patients and two unaffected volunteers. The flowers, leaves, stalks of wild parsnip, yarrow and cow-parsnip were applied to the arms; control areas were protected from sunlight by adhesive plaster and tests areas were exposed to the sunlight. Only the wild parsnip exposed to sunlight gave positive results. Reddening of the skin appeared in twenty-four hours, followed by small blisters in forty-eight to seventy-two hours. Aqueous and alcoholic extracts of the same plant were then painted on the arms of four subjects, one arm exposed to sunlight and the other covered. All four again produce reddening of the skin followed by slight blisters with both extracts of the wild parsnip but not with other plants.

Other plants are known to produce a similar effect; most of these belong to the same family as the wild parsnip (*Umbelliferae*) or to the rue family (*Rutaceae*).

Electronics Centre in London

THERE is no doubt that electronics is a very important science in modern life but many scientists and industrialists feel rather at a loss to know exactly where and how it can be applied. The new Electronics Centre opened at 83, Piccadilly London, W.1. by Cinema Television Ltd. and Dawe Instruments Ltd. will help to solve this difficulty. Here visitors can see a very wide range of electronic instruments and they will also be able to discuss problems and difficulties with representatives in attendance. The showrooms are open daily from 9 a.m. to 12.30 p.m. and from 1.30 p.m. to 5.30 p.m., Monday to Friday inclusive.

Science Exhibition for the Blind

THE first Scientific Exhibition designed for blind persons was held at the Science Museum, South Kensington, in June. It was arranged by the Science Museum in conjunction with the National Institute for the Blind and covered a wide range of popular science. It included models and apparatus relating, for example, to the many forms of transport, railways, shipping and aircraft, to mining, the textile industries, hand and machine tools, time measurement, meteorology, printing and typewriting.

Descriptive labels, transcribed into Braille, explained the exhibits and printed labels were available for escorts to read to those not proficient in Braille.

The A.Sc.W. and Politics

At the annual meeting of the Association of Scientific Workers the Executive Committee presented a long report whose purpose was to dispel suspicions that the Association was controlled by Communists. The report says that statements in the Press that the Executive Committee is committed to Communist Party policy are untrue. It continues:

"The T.U.C. memorandum entitled *Defend Democracy* in which the General Council examines and warns against Communist activities in the trade unions was sent to all branches and in this matter, as in all others, the Executive Committee scrupulously adhered to Council decisions.

"No member is debarred from full participation in the work of the Association because of his or her political views, and that there are Communists in its ranks is as true of the A.Sc.W. as it is of any trade union or professional organisation. The Association is a body for all scientific workers in which discrimination on political grounds has no place.

"The Executive Committee is aware that there are people who regard with distaste the activities of the Association in promoting the professional interests of scientific workers. Such people are some-

times led to believe that those activities are inspired by Communists. There is even a tendency in some quarters and in certain sections of the press to label as Communist policies with which they disagree. This trend is regrettable but it cannot be allowed to deter the A.Sc.W. from pursuing the aims for which it was founded and to which thousands of scientific workers of all shades of opinion subscribe.

"The Executive Committee is convinced that the Association must not indulge in activities or make pronouncements on political matters which would have the effect of narrowing its appeal and of rendering it less able to represent the wide range of views to be found in its ranks at present. There is need for the exercise of a full sense of responsibility by sections of the Association at all levels. Particularly is this the case in regard to public pronouncements, resolutions to bodies with which the A.Sc.W. has relations and communications to the Press. All those who speak in the name of the Association in the branches, areas, committees and Executive Committee should feel this sense of responsibility and exercise due circumspection in their activities and utterances."

Some of the most interesting discussions at the meeting arose out of resolutions connected with trade union policy.

Lord Boyd Orr was elected president in succession to Professor J. D. Bernal.

Survey of Thames Estuary

At the request of the Port of London Authority the Water Pollution Research Laboratory of the Department of Scientific and Industrial Research has begun a detailed survey of the River Thames from Teddington to the sea, a distance of about 60 miles, in order to study the causes and investigate the sources of silt in the river and to observe the velocities, direction and duration of the tidal currents on the ebb and flood at varying depths during the neap and spring tides.

At the same time a scale model of the river, reproducing existing conditions and tidal variations, is being constructed by the Hydraulics Research Organisation of the Department of Scientific and Industrial Research determine to overcome excessive silting occurring in certain reaches and thus reduce the heavy dredging programme now necessary in the navigational channels.

The survey, which it is expected will take at least two or three years to accomplish, will be carried out by staff which will include chemists and a hydrographer, and the headquarters will be at Tilbury where the Port of London Authority has provided a laboratory and a specially equipped 75-ft. motor launch.

The Bookshelf

No Place to Hide. By David Bradley. (London, Hodder and Stoughton, 1949; 191 pp., 7s. 6d.).

This book has the form of a graphic day-by-day log of the atom bomb trials carried out at Bikini.

The author prefaces his book with a prologue in which he skillfully prepares his reader for a critical analysis of the implications of atomic energy in regard to the future of mankind. But the prologue turns out to be a prelude to something that never properly develops.

Briefly, he vehemently rebels against the official American attitude which creates in the public mind a feeling of false security by its emphasis on the exclusive possession of the bomb. Rightly he warns that the days of exclusivity are running out. Having learnt at Bikini much about the public health problems connected with fissionable materials, Dr. Bradley wisely points out that the lessons of Bikini no longer concern merely the militarist and the scientists: they involve the whole of mankind. "For their own protection they (the public) will have to match natural laws with civil laws. Science and sociology are as inseparable now as man and his shadow." However, if in subsequent pages the reader expects the author to expand on his theme he will be disappointed. This is regrettable since the prologue is the crystallisation of some extremely sane reasoning which mankind will have to face sooner or later.

Yet the book is not lacking in merit,

and Dr. Bradley proves that he is an acute observer. From the objective mind of the medical man emerges a sober and factual record of Bikini which will help to destroy the hysteria created by certain irresponsible writers. For that reason alone *No Place to Hide* is amply justified.

D. L.

A Textbook of Entomology. By Herbert H. Ross (Wiley, New York; London, Chapman & Hall, 1949, 532 pp., 36s.).

This should prove a useful book, not only to the specialist in some other branch of biology who wishes to have a general knowledge of entomology, but also to the general reader of scientific literature who is interested in insects. It is, the author states, an introductory textbook, written from an historical angle. The general chapters on the Arthropoda and on the Geological History of Insects are especially useful in this respect, while even that on *The Growth of North American Entomology* is a good deal less parochial than its title implies and is a feature which might well be copied elsewhere. Useful, too, is the short section dealing with reasons for the success of insects as a group, although this might well have been enlarged without upsetting the balance of the book as a whole.

The chapters on morphological aspects are readable and straightforward, the section on mouthparts (always one of the most confusing to the student) being

extremely clear. In dealing with classification, the author admits that his keys to orders and families are intended primarily to aid beginners to realise the types of differences used in delimiting orders and families and to give them practice in the actual manipulation of the keys. This, again, is an excellent idea in a book of this size, since keys are one of the perennial stumbling blocks: if they are comprehensive, they tend to occupy far too much space, and if they are incomplete or badly arranged, they tend only to confuse the student. Practice in their use is, as Mr. Ross realises, essential.

The large section on classification is also good in other respects and the species selected for illustration are in most cases sufficiently similar to European types. One bad omission, however, is that there is seldom any indication of the size of the species shown, and this lessens the value of this part of the book, especially for the lay reader. This failing is due presumably to the fact that the illustrations are almost entirely taken from other publications, some of which indicate the size of their subjects, while others do not.

As might be expected in a transatlantic book of this type, the chapter on *Ecological Considerations* discusses its subject almost entirely from the economic point of view (as opposed to that of the field worker in natural history, which would be the case in most British books). It is here that the 'angle' of the whole book becomes most obvious, and, indeed, the

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difference between the foundations of American and British entomology (on the economic and natural historical aspects respectively) are apparent. This difference in regional approach apart, the chapter is a good one, putting clearly many of the problems of the ecologist which are often passed over completely in general text-books. Not unnaturally, the final chapter on the control of insect pests has also a strong American bias.

A further feature which lessens the value of the book from the British reader's point of view is that the short reading list at the end of each chapter refers, almost inevitably, to American works, with the exceptions of those of the late A. D. Imms and of Dr. Wigglesworth; one notable and surprising omission is any reference to the great works of the American, Morton Wheeler, on the Social Insects.

From a physical point of view, one other fact emerges, due one presumes to the greater availability of certain types of paper in the U.S.A.: this is, for its size, an extremely solid and heavy book. It is well enough printed to be readable in even a poor light, and it contains a tremendous amount of information. Yet on the book-shelf it occupies no more space than Chrystal's *Insects of the British Woodlands*, for example, which has far fewer words to a page and 200 fewer pages. Under present conditions, with an ever-increasing output of books which the serious worker wishes to retain, and less hope than ever of space in which to put them, this is a point to which British publishers might well pay more attention.

P. B. C.

Shadows in the Sun. By Stephen Taylor and Phyllis Gadsden. (London, Harrap, 1949; 187 pp., 15s.).

HARDLY anywhere in the history of medicine is the romance of man's fight against disease more strikingly demonstrated than in the field of Tropical Diseases. The vast toll they have taken of human life is beyond computing and they delayed and discouraged proper contact between Europe and the East for hundreds of years. It is doubtful if any author could have started with more favourable material, and the two authors of this book—one is a well-known medical writer and the other a specialist in the organisation of Colonial Health Services—have made a great deal of it. Their style is good, the material is attractively presented and illuminated with numerous coloured diagrams, most of which are of very great help in understanding the text—but some of which suffer badly from under-labelling. For example, Chart II shows the world distribution of various tropical diseases—but these diseases are represented only by symbols with no label as to what each of the symbols mean. By hunting through the various chapters one can find out what they represent but not many readers will do this. It may be perhaps obvious to someone who knows something of tropical disease that a red squiggle stands for Hookworm, but to the layman it will mean nothing.

More could have been told us about

leprosy. Father Damien is mentioned in the chapter on this subject but it would have been very interesting to have known more about his life and work. Leper work and organisation of colonies in places other than Fiji would also have been of value and much exciting material about the conquest of yellow fever has been left out. But the omissions are far outweighed by the rest of the book. One of the best chapters is that on Tsutsugamushi disease and the discovery of its identity with scrub typhus. Here the introduction of personalities and the interesting history of the disease has made fascinating reading.

Although the text is a little laboured in parts and although it does not quite find the human touch in others, it is an excellent, readable and authoritative presentation of a highly important subject which the general public ought to know more about.

GEOFFREY H. BOURNE

Mammalian Physiology. By F. E. D'Amour and F. R. Blood. (University of Chicago Press, 1949; London, Cambridge University Press, 176 pp., and 130 plates, 15s.).

ONE of the great difficulties in the study of mammalian physiology is the supply of mammals of suitable size. The animals most widely used are the cat and the dog and in this country in particular the difficulty of obtaining them has produced what can almost be regarded as a crisis in mammalian physiology.

Drs. D'Amour and Blood have shown how the conventional experiments in mammalian physiology can be carried out on the laboratory rat, which can, of course, always be obtained in sufficient numbers for this purpose. The smallness of the rat is a handicap and experiments on it call for a precision and an expertness of technique which not many students possess. This new manual of practical physiology, however, contains a wealth of illustrations (photographs and diagrams) and it certainly makes the procedures look simple enough. The use of this manual and of the rat for class experiments ought to be given serious attention by teachers of physiology in this country.

The Art of Bird Photography. By Eric Hosking and Cyril Newberry. (London, Country Life, 2nd edn., 1949, 103 pp., 10s. 6d.).

Few teams can be so well qualified to write on their subject as Hosking and Newberry on Bird Photography, and one therefore expects the highest standard in such a book as this. The new edition includes chapters on flashlight and colour work, with examples of these new techniques; the former are indeed superb, but the authors seem less happy when working in colour, though this may be more due to the printing than to the quality of the originals.

A more serious criticism is that this book still leaves the art, from a practical point of view, far beyond the scope of the

amateur photographer of normal means. That 'the reflex has no equal' for the beginner is probably true, but when one lists the other equipment with which the authors would have him begin, his pocket and his transportation facilities will surely have given out. Bird photography would remain, in fact, a hobby for the moneyed amateur who has also a car, were it not for the really first-class results which we have seen produced by real amateurs, with no more than an ancient double extension camera with roll-film adapter, simple tripod and few pieces of sacking for a hide. Perhaps a later edition will really tell the amateur what he can expect from his own, normal equipment: in the meantime, this is an excellent sample of the 'How we do it' (as opposed to 'How to do it') type of book. Finally, one further point: surely a revision such as this need no longer tempt us with accounts of the advantages of film pack, so repeatedly recommended by the authors, but surely now a thing of the pre-war past.

P. B. C.

Simple Geological Structures. A Series of Notes and Map Exercises. By John I. Platt and John Challinor (London, Thomas Murby, 3rd edn., 1949, 56 pp., 5s.).

THE appearance of the third edition of this exceedingly useful book is a timely occasion to congratulate its authors on the popularity it has achieved and the successful rôle it has played in the teaching of map-reading to students. As in previous editions its text is markedly lucid, and its almost terse account of geological map-reading, enables the student to acquire a firm knowledge of the elements of structural geology without tedium or lack of thoroughness. Beginning with the conception of uniformly dipping strata, the illustrated text deals successively with those fundamental elements such as the dip and strike of rocks and the masking effect of breaks in the strata successions—the so-called unconformities. Examples are then given of the technique of composing a geological map from a restricted set of field data, and in this novel way the beginner is shown how fundamental geological principles exercise a strong control over the reconstruction of the geology of those areas wherein the rocks are not plentifully exposed. When dealing with those fractures in the earth's crust, called 'faults', a realistic approach is adopted and the student is left in no doubt as to the 'two-way' character of movements caused by such stratal dislocations. Each particular aspect of geological map-reading is clearly illustrated by well-designed map-exercises, and from the experience of its many users it is evident that no better form of treatment of this exceedingly important branch of geology has yet been devised. However, by way of suggestion, for future editions it would be an improvement to include three-dimensional drawings as part of this book, and also to advance its scope to include underground contour maps as well as isopachyte maps.

W. DAVID EVANS

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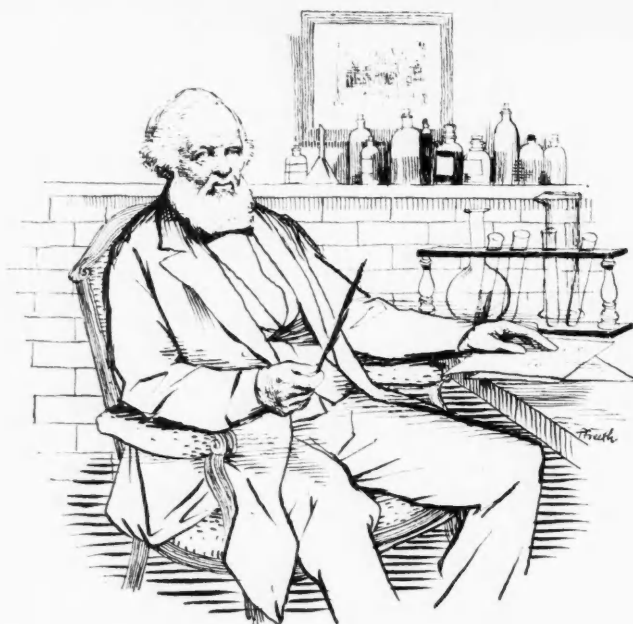
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Thomas Clark,

a Scottish doctor, made the important discovery that hard water can be softened by chemical means. A common cause of what is known as "temporary" hardness is the presence of dissolved calcium

bicarbonate. This can be removed by boiling, the "hardness" being turned into insoluble calcium carbonate—familiar to most people as the "fur" in kettles. Temporary hardness not only wastes soap, but is a serious defect in water used for industrial purposes. The "fur" deposited inside boilers and pipes reduces their efficiency and leads to undue fuel consumption. Clark discovered that the correct quantity of lime added to temporarily hard water causes chemical reactions which change both the lime itself and the unwanted calcium bicarbonate into an insoluble carbonate. This can be removed, leaving the water soft, and suitable for use in steam boilers and for industrial processes.

Clark was born in Ayr in 1801. Thirty years later he obtained an M.D. at Glasgow University, but instead of practising medicine he went to work at the St. Rollox chemical works. In 1833 he was appointed Professor of Chemistry at Marischal College, Aberdeen, where he remained until his retirement twenty-seven years later. He died in 1867, but his memory is perpetuated in "Clark's method" of water softening, which is still in use. All users of water—from the power engineer to the housewife—owe an incalculable debt to Clark's investigations.



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